POWER

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POWER PLUS

By Frederick Moxon

"More power to ye!" An old-time phrase,
Half-jestingly repeated,
Yet fitting well these newer days
Whose coming men have greeted
With firmer faith and stronger wil!
To win life's best achieving;
A creed of Power, yet human still,
And warm with true believing.

More power to men of loyal breed
Who seek to serve the nation!
More power of thought, more power of deed,
Fused in cooperation!
More power of heart, more power of hand,
More power of brain and sinew!
Till Power and Service through the land
For lasting years continue.

A. CONWAY PEYTON

Placing Valves in Unsafe Positions

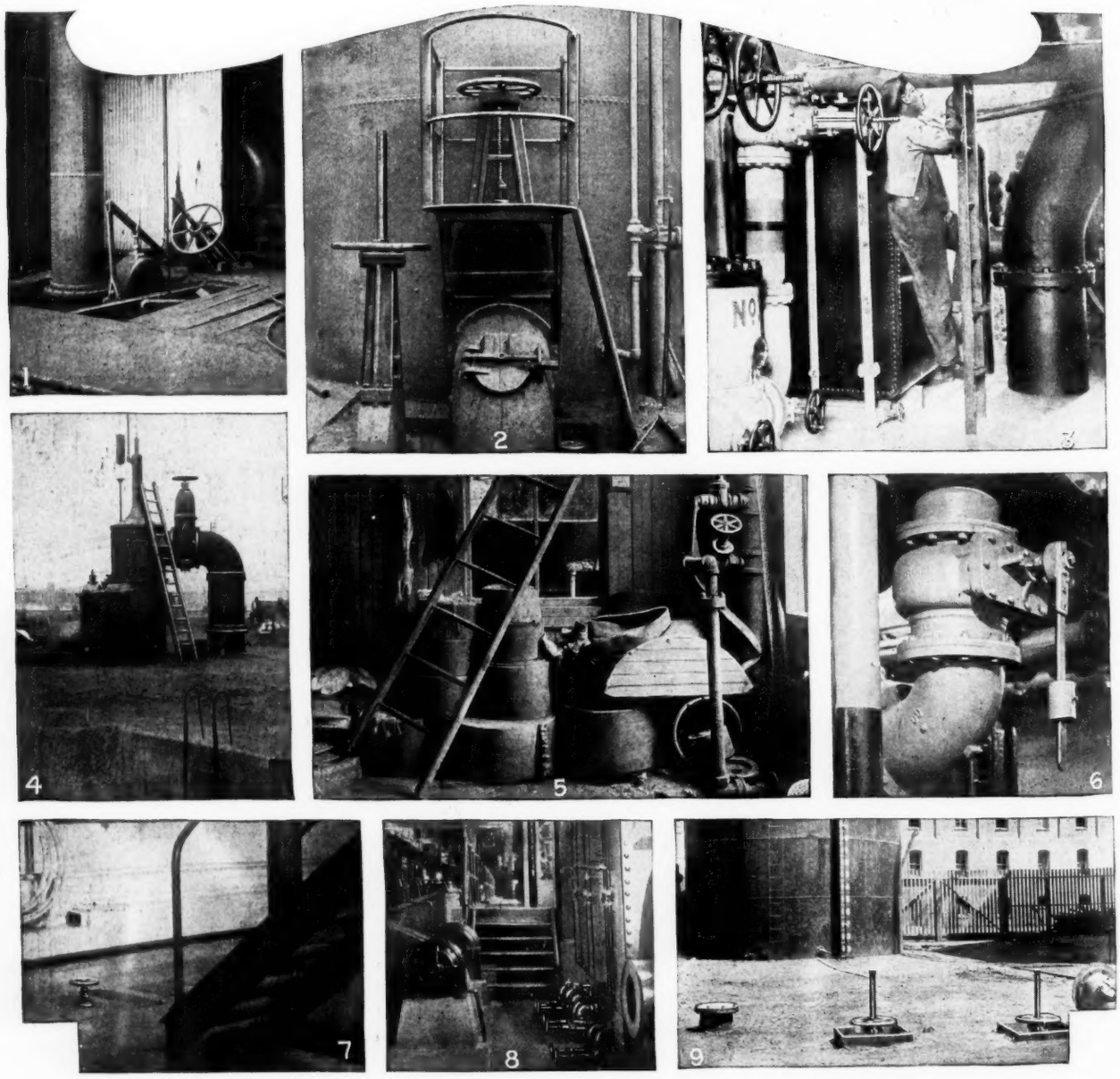
BY V. R. HUGHES

Valves are not always installed in the most convenient location to be quickly reached, and sometimes when they are conveniently located they constitute a tripping or bumping hazard. A number of such installations are illustrated.

VALVES that have to be operated frequently or quickly should be accessible, so that they can be reached safely even though the room in which they are located may be filled with smoke or steam. Often the timely opening or closing of a valve will save lives or prevent a shutdown of the station. Valves are generally conveniently located when installed, but as time goes on obstructions such as loose material, boxes and sometimes hot objects or moving machines are placed so that they cannot be quickly and safely reached.

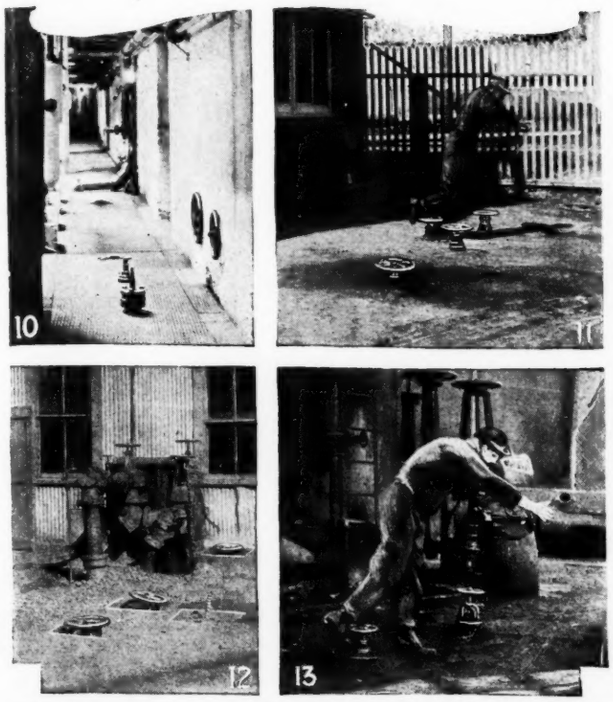
Stop and blowoff valves should be protected so that they cannot inadvertently be opened on a boiler that is down for cleaning, repairs or inspection.

There have been many serious scalds from opening steam header, feed-water and blowoff valves, admitting steam or hot water into a boiler in which there was a workman or an inspector. This is more especially so with blowoff valves where there is a common blowoff pipe or blowdown tank. Often the boiler washer will open the blowoff valve so connected to drain the boiler,



FIGS. 1 TO 9. ILLUSTRATIONS OF HAZARDOUS VALVE INSTALLATIONS

Fig. 1—Valve wheel over pit. Fig. 2—Safety platform. Fig. 3—Protruding valve stem. Fig. 4—Ladder necessary to reach valve. Fig. 5—Hose and valve obstructed. Fig. 6—Weight a danger. Fig. 7—Valve stem at stair approach. Fig. 8—Valve stems obstruct passageway. Fig. 9—A tripping menace.



FIGS. 10 TO 13. VALVE STEMS PROTRUDING ABOVE THE FLOOR AND GROUND LEVEL A SOURCE OF ACCIDENTS

forgetting to close it again before getting back into the boiler, there being no pressure on the line at the time to remind him. Later, if one of the other boilers is blown down into the common blowoff line, hot water is blown into the dead boiler, scalding the man inside. Such valves should always be locked by the foreman or removed and the pipe blanked off with a blind gasket.

Boiler stop valves should have a continuous runway leading to each boiler valve. The runway should be rail-guarded on both sides so that an attendant can follow the hand-railing to each boiler discharge valve in the dark or with the room full of steam.

The pop safety valve should never discharge across a runway or toward the stop valves. The safest way is to have a vertical discharge pipe with a drip hole at the bottom on each valve. Workmen going upon the roof trusses over safety valves so equipped should be warned about the danger of the valve operating and blowing steam over them.

Again, a good valve may be conveniently installed, but in time the handwheels become detached or broken, causing the valve to become inoperative unless special tools are at hand. Frequently, the handwheels are removed with the idea that the valve will not be changed from its open or closed position, but there is no assurance of this as a pipe or monkey wrench will usually suffice to operate the valve and injury or damage may result from its being opened or closed unknown to the proper authority. The handwheel should be left on the valve with a danger sign attached, stating that the valve is not to be operated, or the wheel should be locked with a padlock and chain. In some plants round split sheet-metal covers are placed over the handwheels, and when these are locked the wheels cannot be turned without removing or destroying the covers.

Some of the conditions enumerated in the foregoing are shown in the accompanying illustrations.

In one instance the throttle valve on a turbine-driven boiler-feed pump is located so high that it is necessary for the operator to stand on the suction pipe of the pump and bearing of the turbine to open or close the valve. Fig. 1 shows a valve with the handwheel at the edge of an open pit. When operating the valve there is danger of the operator falling into the pit.

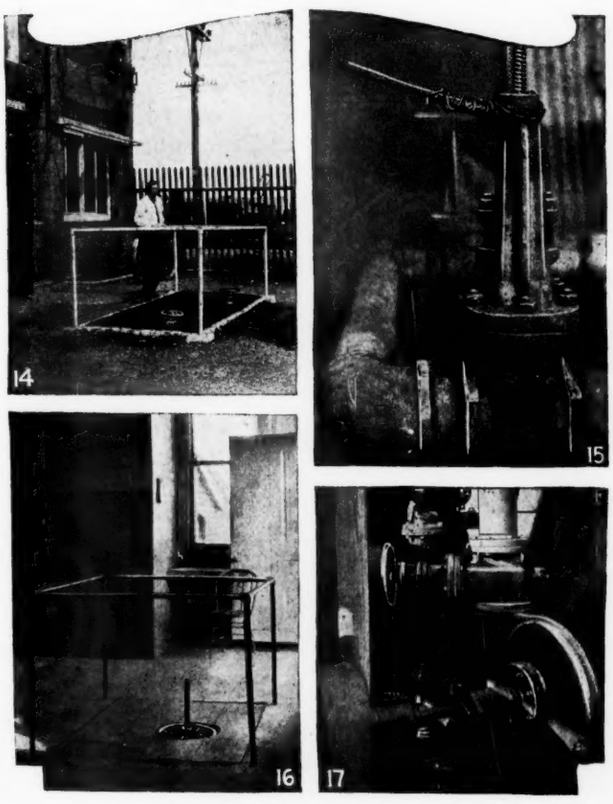
Frequently, large gate valves are so placed that it is necessary for the operator to stand on a ladder to operate them. Such an installation is shown in Fig. 4. That there is danger of the operator falling from the ladder is evident. As a contrast, Fig. 2 shows a large gate valve provided with a substantial platform and guard rail to protect the workmen from falling.

Carelessness of workmen frequently makes safety apparatus practically useless, as is shown in Fig. 5. Although the hose valve is conveniently located, it and the hose are obstructed with loose and junky material.

In Fig. 3 is shown a gate valve on a hotwell discharge line so located that when the valve is open an operator climbing the iron ladder to the condenser platform is in danger of having his back injured by the prejecting valve stem.

In Fig. 6 is shown an exhaust relief valve alongside a narrow passageway. When the relief valve is closed the lever is horizontal, but should the valve open the lever drops to a vertical position. There is danger of the weight working loose from the end of the lever and falling and injuring someone.

Fig. 7 shows a valve bonnet and valve wheel projecting above a pipe-trench cover at the foot of a stairway. This constitutes a serious tripping hazard.



FIGS. 14 TO 17. GOOD AND BAD EXAMPLES OF VALVE INSTALLATION

Fig. 14—Valve stems protected by railings. Fig. 15—A poor makeshift. Fig. 16—Valve pit guarded by railing. Fig. 17—Valve placed at inconvenient angle.

Oil pressure line valves with stems and wheels projecting into a commonly used passageway constitute a serious tripping hazard, as is shown in Fig. 8.

In Fig. 10 valve stems and stuffing-box are shown projecting through iron pipe-trench covers along a commonly used passageway.

Figs. 9, 11, 12 and 13 show underground pipe valve wheels and stems projecting above the ground in passageways, constituting a tripping hazard.

Fig. 14 shows the valve stems and wheels as in Fig. 11, protected by a pipe-guard railing.

Fig. 16 shows a large gate valve and pit guarded by a pipe railing. The opening in the pit cover should be larger so that the operator would not be in danger of injuring his hands when operating the wheel.

Fig. 15 shows a gate valve with the arms and rim of the handwheel broken off. A makeshift handle has been substituted, which makes the operation of the valve uncertain and the whole slovenly.

The final view, Fig. 17, shows the gate valve on a centrifugal-pump discharge installed with the handwheel in close quarters, compelling the operator to lean over the pump and possibly the revolving shaft. The valve could just as well have been swung around about two bolt holes, thus making it convenient to reach from the front of the pump.

Hytempite Furnace Cement

Ordinary fireclay will soon burn out and crumble when used as a binder for furnace firebrick, thus necessitating frequent repairs in order to keep the furnace in proper condition. A number of prepared furnace cements are on the market for use as binding material for the brickwork, one of which, known as Hytempite, is manufactured by the Quigley Furnace Specialty Co., Inc., 26 Cortlandt St., New York City. This cement possesses such qualities as to enable it to expand and contract to the varying temperatures without losing its bond on the furnace brickwork. Furnace conditions vary according to the type of boiler plant, and the operating conditions under which some of them are fired are quite severe. For instance, the firebox of the heating boilers (Fig. 1) used on the electric trains running into New York City are subjected to severe usage owing to the jar caused by the frequent stopping and starting, as well as that of the train movement. As a result the joints of the brickwork in the heating-boiler furnace deteriorate after a week or ten days, when repairs are necessary, thus showing that fireclay is not a suitable binder for this kind of furnace. The condition of the furnace after about ten days' run is shown in Fig. 3.

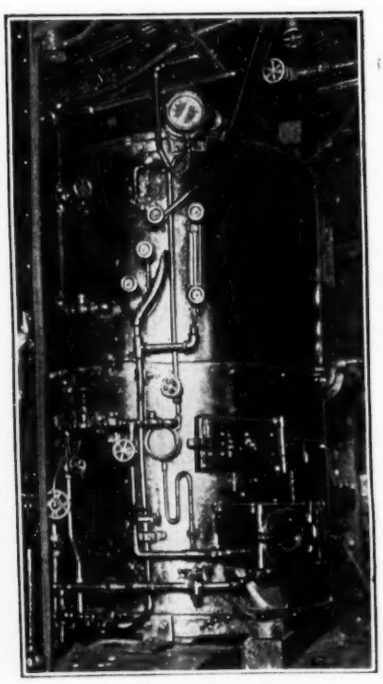


FIG. 1. HEATING BOILER

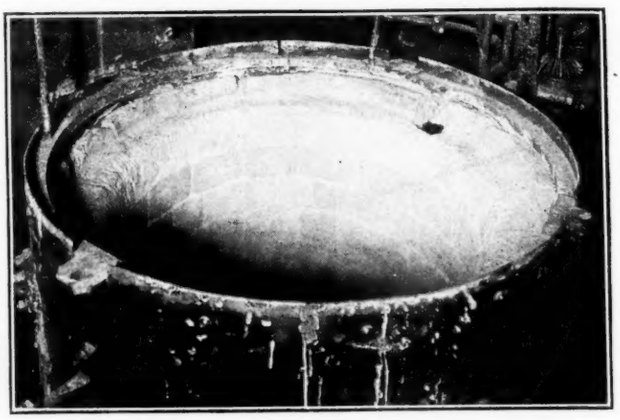


FIG. 2. BRICK LINING SET WITH HYTEMPITE

To overcome this trouble the New York, New Haven & Hartford R.R. has recently used Hytempite as a bond for the firebrick on the boiler furnaces in one of its electric locomotives. Fig. 2 shows its application. It is not known how long this furnace lining will stand up, as this is the first boiler that has been treated, but after being in service for about seven weeks it was still in good condition. This, compared with ten days' service, speaks well for the merits of the binding cement and the indications are that much better results will be obtained with the boiler furnace lining laid up in this manner.

This cement is suitable for use in laying up boiler furnaces in power plants as well as furnaces used for other purposes where the heat is intense.

FIG. 3. INTERIOR OF FURNACE AFTER 10 DAYS' RUN

How Much Should a Flywheel Weigh?

By RUFUS T. STROHM

The weight of a flywheel depends on the allowable variation in rotative speed and the diameter of the wheel. It may be calculated approximately by the method explained in the article, using simple rules and ordinary arithmetic.

ORDINARILY, the operating engineer is not concerned about the weight of the flywheel on any of his engines, because that is a matter which is fixed by the designer and builder; nevertheless, he may be curious to know what factors control the size and weight of a flywheel, and how these points are determined before the engine is built. To do so, he must first have some idea as to what a flywheel does.

The purpose of a flywheel on an engine is to produce a desired degree of steadiness in the speed of rotation of the crankshaft. Of course, the governor is used for the same purpose; but there is a great difference between the fields of action of the two. The governor adjusts either the steam pressure or the cutoff according to the load on the engine, and so maintains a practically uniform number of revolutions per minute over long periods. The flywheel, on the other hand, prevents

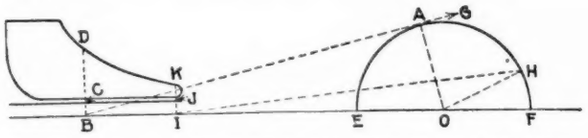


FIG. 1. VARIATION OF PRESSURE ON CRANKPIN DURING STROKE

any undesirable change of speed within the limits of a single revolution.

The factors that tend to produce a variation of rotative speed within a revolution of the crankshaft are three: The changing pressure of the steam in the cylinder, the changing relative positions of connecting-rod and crank, and the changing force required to set the reciprocating parts in motion during the early part of the stroke and bring them to rest during the later part of the stroke.

The effect of the first two of these factors may readily be understood by referring to Fig. 1, which shows an ordinary indicator diagram and two different positions of connecting-rod and crank. When the crank is at *OA*, the crosshead is at *B*, and the forward pressure per square inch of piston area is represented by *CD*. As the connecting-rod and the crank are almost at right angles at *A*, practically the entire thrust of the rod is available for turning the crank; for it must be remembered that the force which turns the crank is that which acts at right angles to *OA*, or tangent to the crankpin circle *EAF*, as indicated by the arrow *G*.

When the crank is at *OH*, the crosshead is at *I*, and the forward pressure per square inch of piston area is represented by *JK*. This is much shorter than *CD*, showing that the force exerted on the crankpin is considerably smaller near the end of the stroke than near the beginning. Furthermore, the relative positions of the crank *OH* and the connecting-rod *HI* are such that most of the thrust of the connecting-rod merely produces pressure on the crankpin and the crankshaft bearings, and has little effect in turning the crank *OH*. As a consequence, there is a wide variation in the turning force on the crank throughout the stroke; and as this force determines the amount of work being done during any interval, it follows that the work expended in rotating the crankshaft varies according to the position of the crosshead.

Now, during a short interval, as, for example, a single stroke of the engine, the load may be considered constant. The load then constitutes a uniform resistance which must be overcome by the turning force acting at the crankpin. But, as this turning force is variable, the work done at the crankpin is alternately greater and less than the uniform load under which the stroke is made. It is for the purpose of overcoming this inequality that the flywheel is used. The flywheel absorbs and stores up in itself the excess of work done while the turning force is greater than the resistance; and when the turning force becomes less than the resistance, toward the end of the stroke, the flywheel gives back to the crankshaft the work that it stored up during the early part of the stroke.

Effect of Weight of Reciprocating Parts

The third factor tending to cause variation in the turning force is the effect of the reciprocating parts. At the beginning of the stroke these parts are at rest; near the middle of the stroke they are moving at the same speed as the crankpin; and at the end of the stroke they are again at rest. To bring these parts up to speed, force must be applied; and when they have been set in motion, force must be applied to bring them to rest again. During the early part of the stroke, therefore, a part of the work of the steam on the piston is used in speeding up the reciprocating parts, and so the force acting on the crankpin is correspondingly reduced; but during the later part of the stroke, while these parts are being brought to rest, they give up the work stored in them and so add to the force exerted on the crankpin. The heavier the reciprocating parts and the greater their speed, the greater is the amount of work they alternately take up and give back.

To find the weight of flywheel required for an engine, it is necessary to start with the indicator diagrams. If the engine has not been built, the theoretical diagrams may be constructed according to the known data. If the engine has already been built, and the weight of the flywheel is to be checked, diagrams may be taken in the usual way.

To illustrate the method to be followed, let it be required to find the weight of flywheel for an 18 x 24-in. double-acting engine cutting off at one-fifth stroke, with a clearance of 6 per cent., an initial pressure of 120 lb., absolute, a compression pressure of 60 lb., absolute, a back pressure of 18 lb., absolute, a connecting-rod four times as long as the crank, and a rotative speed of 250

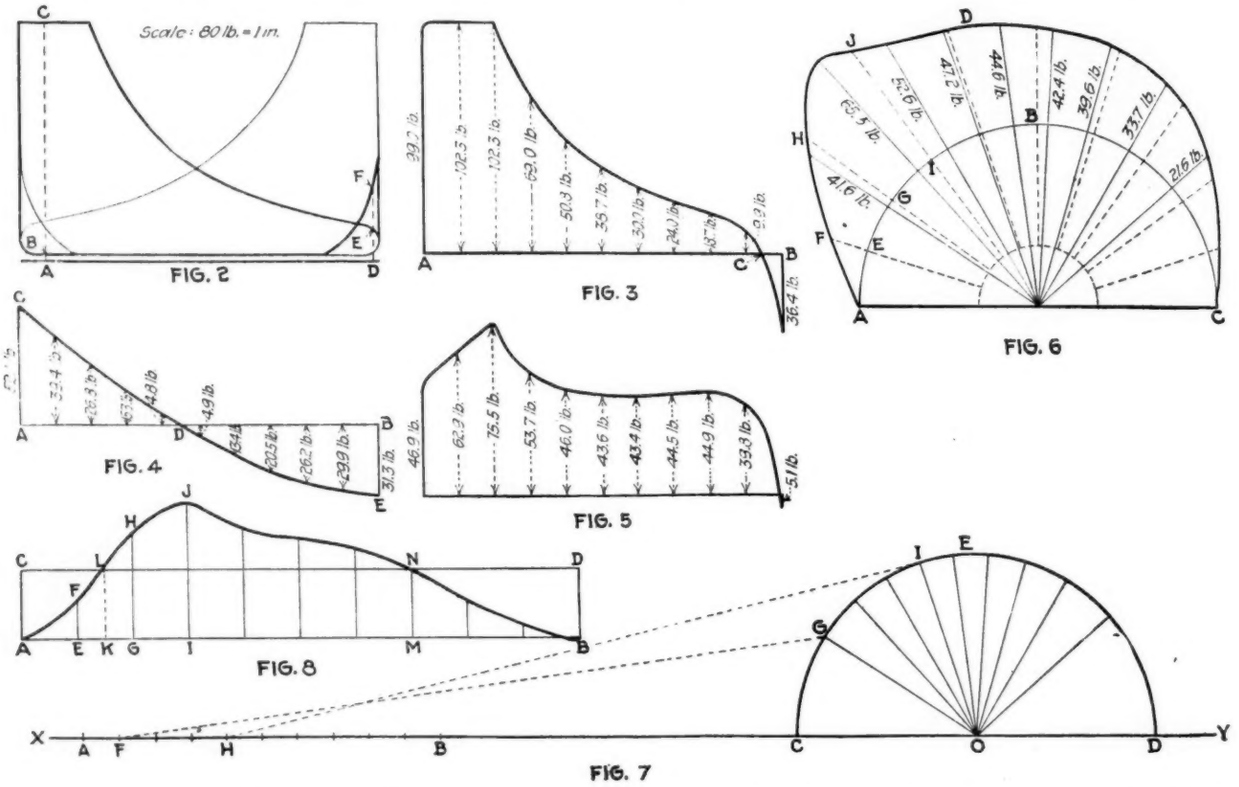
r.p.m. Assume further that the total weight of the reciprocating parts is 500 lb., which includes piston, piston rod, crosshead, and from half to two-thirds of the weight of the connecting-rod.

The theoretical diagrams constructed according to the foregoing data are shown in Fig. 2. At any instant the net steam pressure per square inch, urging the piston forward, is the difference of pressures on opposite sides. For example, at the position *A* the net pressure per square inch is represented by *BC*. But at the position *D* the net pressure is *EF*, which is negative; that is, the pressure opposing forward movement is greater than that tending to produce forward movement. If, therefore, the forward-pressure line of one diagram is combined with the back-pressure line of the other diagram, the result will be a diagram of net pressures urging the piston forward. This combined diagram is indicated by the heavy outline in Fig. 2. If the ordinates of the combined diagram are laid off from a straight base line, the diagram in Fig. 3 will result, the part lying below the line *AB* representing the back pressures that are in excess of the forward pressures. At the point *C*, where the curve crosses *AB*, the steam pressures on opposite sides of the piston are equal and the net pressure is zero.

The ordinates of the diagram in Fig. 3 do not, however, represent correctly the pressures that produce the turning of the crank, because some force is required to speed up the reciprocating parts, and also because the reciprocating parts in slowing down at the end of the stroke increase the effective force that acts on the crank-pin. The force required to change the speed of the reciprocating parts, called the inertia force, may be calculated for various positions of the piston and then subtracted from or added to the net forward pressure at that point, thus giving the actual pressure transmitted to the connecting-rod. The inertia force may be found as follows:

Rule: Multiply together 0.000018 times the weight of the reciprocating parts in pounds, the stroke in inches, the square of the number of revolutions per minute, and the inertia-force factor taken from Table I, and divide the product by the square of the diameter of the piston in inches. The quotient will be the inertia force per square inch of piston area.

The speed of the reciprocating parts changes continuously throughout the stroke, and the inertia force therefore has different values at different points in the stroke. Table I gives the values of the factors to be used in the foregoing rule, to find the inertia force at equal intervals of 0.10 stroke in the movement of the piston, starting from the head end. The minus sign in front of a factor indicates that the inertia force opposes the forward movement of the piston, and the plus sign that it assists the forward pressure on the piston.



FIGS. 2 TO 8. DIAGRAMS FOR FINDING ENERGY ABSORBED AND GIVEN UP BY FLYWHEEL DURING ONE STROKE

By the aid of the rule just given, it is a simple matter to find the value of the inertia force at intervals of one-tenth of the stroke. Take, for example, the zero position, with the piston at the head end of the cylinder. At this position the inertia-force factor has a value of 1.25, according to Table I. The other values to be used are given in the data assumed for the engine. Then, the inertia force per square inch of piston at the beginning of the forward stroke is

$$\frac{0.000018 \times 500 \times 24 \times 250^2 \times 1.25}{18^2} = 52.1 \text{ lb.}$$

That is, a pressure of 52.1 lb. per square inch of piston area is required to set the reciprocating parts in motion

from the head-end dead-center. By a similar calculation the inertia force at each one-tenth of the stroke may be found. After the inertia forces for all points in the stroke are calculated, they should be laid off in the form of a diagram, as in Fig. 4. A straight line *AB* equal to the length of the indicator diagram is drawn and divided into ten equal parts. At these points ordinates are erected and the calculated values of the inertia forces are laid off to the same scale as that used in the indicator diagram, or 80 lb. to the inch. Thus, the distance *AC*, which represents 52.1 lb., must have a length of 52.1 ÷ 80 = 0.65 in.; and similarly with the other lengths. The values calculated by the use of an inertia-force factor with a minus sign are laid off above the line *AB* and those found by using a factor with a plus sign are laid off below *AB*. The smooth curve *CDE* drawn through the ends of these ordinates crosses the line *AB* at *D*, indicating that at this point the reciprocating parts are moving at their greatest speed and therefore are neither opposing nor aiding the pressure on the piston.

The next step is to find the actual pressures per square inch of piston area effective in producing rotation of the crankshaft. The diagram in Fig. 3 shows the net forward pressures, and Fig. 4 shows the inertia forces that oppose or assist the net forward pressures; therefore, if the pressures marked on the ordinates above the base line in Fig. 4 are subtracted from the corresponding pressures in Fig. 3, the remainders will represent the pressures available for producing rotation of the crank, up to the point where the inertia force becomes zero. Beyond this point the pressures on the ordinates below the base line in Fig. 4 must be added to the corresponding pressures on the diagram in Fig. 3, to find the pressures available for rotating the crank during the remainder of the stroke.

TABLE I. INERTIA-FORCE FACTORS FOR VARIOUS PISTON POSITIONS

Part of Forward Stroke	Ratio of Connecting-Rod to Crank				
	4	4.5	5	5.5	6
0.00	—1.250	—1.222	—1.200	—1.182	—1.167
0.10	—0.945	—0.921	—0.907	—0.896	—0.887
0.20	—0.644	—0.636	—0.630	—0.629	—0.622
0.30	—0.368	—0.369	—0.369	—0.370	—0.371
0.40	—0.114	—0.121	—0.127	—0.132	—0.136
0.50	+0.117	+0.106	+0.096	+0.088	+0.081
0.60	+0.321	+0.307	+0.296	+0.287	+0.279
0.70	+0.493	+0.480	+0.471	+0.463	+0.457
0.80	+0.628	+0.621	+0.615	+0.613	+0.610
0.90	+0.717	+0.723	+0.728	+0.733	+0.737
1.00	+0.750	+0.778	+0.800	+0.818	+0.833

TABLE II. TANGENTIAL-PRESSURE FACTORS FOR VARIOUS PISTON POSITIONS

Part of Forward Stroke	Ratio of Connecting-Rod to Crank				
	4	4.5	5	5.5	6
0.00	0.000	0.000	0.000	0.000	0.000
0.10	0.662	0.655	0.649	0.644	0.641
0.20	0.868	0.861	0.854	0.849	0.844
0.30	0.979	0.970	0.964	0.959	0.955
0.40	1.026	1.019	1.013	1.009	1.005
0.50	1.024	1.019	1.015	1.013	1.011
0.60	0.978	0.976	0.975	0.974	0.973
0.70	0.889	0.890	0.891	0.893	0.894
0.80	0.751	0.755	0.759	0.762	0.765
0.90	0.542	0.549	0.554	0.558	0.561
1.00	0.000	0.000	0.000	0.000	0.000

Fig. 5 is the effective-pressure diagram obtained by combining the pressures in Figs. 3 and 4 in the manner just explained. At the beginning of the stroke, the effective pressure is 99.0 — 52.1 = 46.9 lb., the pressures of 99.0 lb. and 52.1 lb. being taken from Figs. 3 and 4 respectively, at corresponding piston positions. At the end of the stroke, the pressure in Fig. 3 is negative and has a value of 36.4 lb.; consequently, when the pressure of 31.3 lb is added to it, the sum is — 36.4 + 31.3 = — 5.1 lb. Therefore the value of 5.1 lb. is laid off below the base line in Fig. 5, to represent a negative pressure.

The pressures shown by the diagram, Fig. 5, are not applied at the crankpin in a direction at right angles to the crank; and as the force acting tangent to the crankpin circle is that which actually causes the crank to turn, the tangential pressures at the crankpin for the several positions of the crank must be calculated. This is done by multiplying the pressures shown on the diagram, Fig. 5, by factors taken from Table II, corresponding to the positions of the piston in the stroke.

Calculation of the Tangential Pressure

At the beginning of the stroke, the effective pressure is 46.9 lb. per square inch of piston, as shown in Fig. 5; but the piston rod, connecting-rod and crank are in the same straight line, and so this pressure is exerted wholly as a thrust on the crankshaft bearing, none of it acting to turn the crank. Therefore, the factor in Table II for the zero position is zero. If 46.9 is multiplied by zero, the product is zero; that is, there is no tangential pressure at the beginning of the stroke. The same thing is true at the end of the stroke. At one-tenth stroke, the effective pressure is 62.9 lb. and the factor from Table II is 0.662; consequently, the tangential pressure is 0.662 × 62.9 = 41.6 lb. per square inch of piston area. In a similar manner, the tangential pressure at each of the remaining piston positions may be found.

If the tangential pressures for the several piston positions are laid off on the corresponding positions of the crank, a tangential-pressure diagram will result, such as that shown in Fig. 6. The semicircle *ABC* is drawn with a diameter *AC* equal to the length of the indicator diagram in Fig. 2 and the tangential pressures are laid off outward from the semicircle on the full lines representing the crank positions, to the same scale of pressures as in the preceding diagrams. The curve *ADC* is then the tangential-pressure curve.

The crank positions corresponding to the positions of the piston are easily found by the method shown in Fig. 7. On a straight line *XY* the distance *AB* is laid off to equal the length of the diagram in Fig. 2, and *AC* is made equal to twice *AB*, to represent the length of the connecting-rod, which is twice the stroke, or four times the length of the crank. Then *CD* is made equal to *AB* and the semicircle *CED* is drawn. The stroke *AB* is divided into ten equal parts to show the piston positions.

Finding Crank Position from Piston Positio

When the piston is at *F* it has moved one-tenth of the stroke from *A* and the crank is at *OG*. The point *G* is found by setting a pair of compasses to the length *AC* of the connecting-rod, placing the point of the compasses at *F* and drawing an arc to cut the semicircle *CED*, which it will do at *G*. Similarly, when the piston is at *H*, the crank is at *OI*, the point *I* being found by using *H* as a center and a radius equal to *AC*, and drawing an arc to cut the semicircle. The other crank positions are found in like manner. When they have been found, they are transferred to the semicircle on Fig. 6 and the tangential pressures are laid off, as already explained.

The final step in the drawing of diagrams is to draw the tangential-pressure diagram to a straight base, as shown in Fig. 8. This means simply that the diagram in Fig. 6 is straightened out. First, the semicircle *ABC*

in Fig. 6 is divided into a number of equal parts, say ten, and through these points crank positions are drawn as shown by dotted lines. In Fig. 8 the line *AB* is made equal in length to the semicircle *ABC* in Fig. 6 and is also divided into ten equal parts. Vertical lines are drawn at the points of division, and on them are laid off the ordinates of the tangential-pressure diagram in Fig. 6, measured along the dotted lines. Thus, in Fig. 8, the heights *EF*, *GH*, *IJ*, etc., are laid off exactly equal to the heights *EF*, *GH*, *IJ*, etc., in Fig. 6 and the smooth curve *AFHJB* is drawn.

Work Done on Crank in a Single Stroke

In Fig. 8 the length of the ordinate between the base line *AB* and the curve, at any point along *AB*, represents the tangential pressure at the crankpin, in pounds per square inch of piston, for the corresponding crank position. The length *AB* represents the travel of the crankpin during one stroke of the engine. Therefore, the area of the diagram *AJB* represents the work done in turning the crank during one stroke, to the same scales of pressure and distance as the indicator diagrams in Fig. 2 represent work done on the piston by the steam.

The load on the engine resists the turning of the crankshaft, and as the load is assumed to be uniform throughout the stroke, it may be considered as a uniform resistance acting at the crankpin to oppose the tangential forces urging the crank ahead. This uniform resistance is indicated in Fig. 8 by the height *AC* of the line *CD* above *AB*, representing 32 lb. It is determined by finding the mean ordinate of the diagram *AJB* and multiplying it by the scale of pressures, 80 lb. to the inch. The mean ordinate, 0.386 in., is found by the same method as the mean ordinate of an indicator diagram.

Since *AC* represents the average resistance and *AB* the crankpin travel during one stroke, the area *ACDB* represents the work done in overcoming the resistance during one stroke. It is exactly equal to the area *AJB*, which represents the work done at the crankpin by the steam during one stroke. A little thought will show that this must be true. For, if the work done at the crankpin by the steam were continually greater than the work of overcoming the resistance, the excess would gradually increase the speed of the engine; and if the conditions were reversed, and the resistance were the greater, the engine speed would decrease. With a uniform speed, the average effort on the crankpin remains equal to the average resistance.

Relation of Tangential Effort to Resistance

The diagram, Fig. 8, shows clearly the relative values of the effort and the resistance at all points in the travel of the crankpin. The constant resistance is indicated by the line *CD*, parallel to *AB*. The tangential pressure, or effort, on the other hand, starts from zero at *A*, increases to the point *J*, and decreases to zero at *B*. While the crankpin is moving through the part of its travel represented by *AK*, the tangential pressure is on the increase, and at *K* it is just equal to the average resistance, as indicated by the crossing of the curve and the line *CD* at *L*. While the crankpin travels from *K* to *M*, the tangential pressure reaches its greatest value, and remains greater than the resistance; but at *M* the two become equal, as indicated by the crossing of the lines at *N*. From the point *M* to the end of the stroke the tangential pressure decreases, and just before the end of the stroke it becomes negative, as indicated by the slight drop of the curve below the base line.

During the period in which the tangential pressure is greater than the resistance, represented by the travel of the crankpin from *K* to *M*, the excess of pressure is utilized in causing a momentary increase of speed of the crankshaft. During the remaining parts of the half-revolution, the resistance is greater than the tangential pressure, and the result is a momentary decrease in the speed of the crankshaft. If there were no flywheel on the shaft, these periodic increases and decreases of speed on successive strokes would be sudden and violent; but by the addition of a flywheel the fluctuation of speed may be made as small as may be desired.

The crankshaft alone, because of its relatively small diameter and weight, could very quickly be speeded up or slowed down; but a flywheel, because of the weight of its rim and the distance of that rim from the center of the shaft, cannot be speeded up or slowed down quickly by a force acting at the end of the crank. In an engine with a flywheel, therefore, the variable tangential pressure produces only a small change of speed of the crankshaft and flywheel. The speed increases slightly while the tangential pressure exceeds the resistance and decreases slightly while the resistance exceeds the tangential pressure. The total variation between the greatest and the least speed is regulated by the weight of flywheel. The heavier the wheel the smaller will be the fluctuation of speed, because the excess of tangential pressure or resistance has less effect on a large weight than on a small one.

Flywheel Absorbs and Gives up Work

Work is required to set any body in motion or to increase the speed of a body that is already in motion, and these statements apply to the flywheel of an engine. While its speed is increasing, work is being done on it and is being stored in it; and while its speed is decreasing, it is giving up work that has been stored in it. The flywheel simply absorbs the excess of work while the tangential pressure exceeds the resistance, and gives it back while the resistance exceeds the tangential pressure.

In the diagram, Fig. 8, the area *LJN* represents the work that is stored up in the flywheel during one stroke, and the combined areas *ACL* and *NDB* represent the work that is given up by the flywheel during one stroke. As the average speed does not change, the work absorbed is equal to the work given up; that is,

$$\text{area } LJN = \text{area } ACL + \text{area } NDB$$

The loop below the line *AB* has been neglected because it is so small; but if it were large, it would need to be taken into account. It would form a part of the area *NDB;* and in calculating the mean height *AC*, the area of the loop would be subtracted from the total area above *AB* and the remainder would be divided by the length of *AB*.

The scale of vertical distances in Fig. 8 is 80 lb. to the inch. The length *AB* is 3.14 in., or the length of the semicircle in Fig. 6, which represents half the circumference of the crankpin circle. As the stroke is 2 ft., half the circumference of the crankpin circle is

$\frac{1}{2}$ (3.1416 × 2) = 3.14 ft. Therefore, each inch of length of *AB* represents 1 ft. of travel of the crankpin. Each square inch of area *LJN* then represents 80 × 1 = 80 ft.-lb. of work per square inch of piston area. The area of *LJN* (found by multiplying its mean ordinate by the length of *LN*) is 0.34 sq.in., and the area of the piston of the assumed engine is 0.7854 × 18^2 = 254.5 sq.in. Consequently, the area *LJN* represents

$$0.34 \times 80 \times 254.5 = 6922 \text{ } ft.\text{-}lb. \text{ } of \text{ } work$$

which is alternately absorbed and restored by the flywheel during each stroke of the engine.

It is customary, except in very accurate work, to consider that the flywheel rim does all the regulating of speed during the stroke, and to neglect the steadying effect of the arms and hub, which assist the rim. Consequently, the problem resolves itself into finding the diameter and cross-section of rim that will take up and give out the calculated excess of work. The weight, however, depends on the amount of speed variation allowable, which in turn depends on the class of service for which the engine is intended.

Coefficient of Speed Variation

If the engine is to drive alternating-current generators, the speed of rotation must be very steady throughout the stroke, and the total variation should not exceed $\frac{1}{300}$; that is, the variation in speed of a point on the flywheel rim, between the greatest and least speeds occurring during the stroke, should not be greater than $\frac{1}{300}$ of the average speed of that point. The fraction that represents the ratio of the total speed variation to the normal speed is called the coefficient of speed variation. For various classes of service it may be given the following values:

Engine to Drive:	Coefficient of Speed Variation
Pumps	$\frac{1}{20}$ to $\frac{1}{30}$
Machine-shop tools	$\frac{1}{25}$ to $\frac{1}{40}$
Looms and paper mills	$\frac{1}{40}$
Spinning mills	$\frac{1}{60}$
Direct-current generators	$\frac{1}{150}$ to $\frac{1}{180}$
Alternating-current generators	$\frac{1}{300}$

The weight of flywheel rim required to absorb and give up a known quantity of work may be found as follows:

Rule: Multiply the foot-pounds of work absorbed and given up per stroke by 11,750, and divide the product by the product of the coefficient of speed variation, the square of the number of revolutions per minute, and the square of the mean diameter of the flywheel in feet. The quotient will be the weight of rim in pounds.

In the case of the engine assumed, the flywheel diameter is not stated, and so a value must be given to it. Suppose that a mean diameter of 4 ft. is chosen; that is, the average of the inside and outside diameters of the rim is 4 ft. Assume further that the engine is to drive machine-shop tools. Then its allowable coefficient of speed variation may be taken as $\frac{1}{40}$. Applying the rule, the weight of rim required under these conditions is

$$\frac{6922 \times 11{,}750}{\frac{1}{40} \times 250^2 \times 4^2} = 3253 \text{ } lb.$$

Ordinarily, flywheels are made of cast iron, which weighs about 450 lb. per cu.ft. The volume of the rim, therefore, is

$$3253 \div 450 = 7.23 \text{ } cu.ft.$$

The mean circumference of the rim is 3.1416 × 4 = 12.57 ft.; hence, the cross-section of the rim must be

$$7.23 \div 12.57 = 0.575 \text{ } sq.ft.$$

The area of cross-section in square inches is then

$$144 \times 0.575 = 82.8 \text{ } sq.in.$$

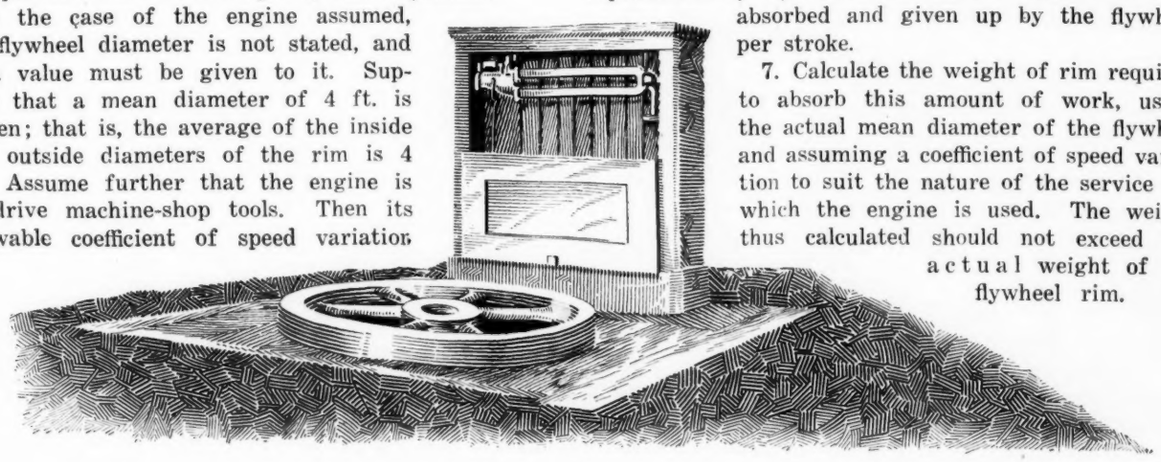
A rim of rectangular cross-section 8¼ in. wide and 10 in. deep will have a cross-sectional area of 82.5 sq.in.; therefore, a flywheel with a rim having a mean diameter of 4 ft. and a section measuring 8¼ in. wide and 10 in. deep will be suitable for the given engine under the conditions assumed. The outside diameter of the rim will be 4 ft. 10 in. and the inside diameter 3 ft. 2 in.

If the engine is already built and in use, the weight of the flywheel may be checked by using practically the same method as that just described. First calculate the actual weight of the flywheel rim as follows:

Rule: Multiply 10 times the mean diameter of the rim in feet by the width of the rim and the depth of the rim, both in inches. The product will be the weight of the rim in pounds.

Next, calculate the weight of the rim by the method outlined in this article, which may be summarized as follows:

1. Take a pair of indicator diagrams from the engine under the normal working conditions.
2. Combine the two diagrams so as to obtain a diagram of net forward steam pressures on the piston.
3. Calculate the inertia forces at several points in the stroke and construct the inertia-force diagram.
4. Combine the inertia-force diagram with the diagram of net steam pressures on the piston, producing a diagram of net pressures on the crosshead pin.
5. From the diagram of net pressures on the crosshead pin, calculate the tangential pressures and draw the diagram of tangential pressures to a semicircular base and then to a straight base.
6. On the straight-base diagram, find the area of that part of the diagram above the line of average resistance, and calculate the total number of foot-pounds of work represented by it, which will be the amount of work absorbed and given up by the flywheel per stroke.
7. Calculate the weight of rim required to absorb this amount of work, using the actual mean diameter of the flywheel and assuming a coefficient of speed variation to suit the nature of the service for which the engine is used. The weight thus calculated should not exceed the actual weight of the flywheel rim.



When Doctors Disagree—I

BY JOHN S. CARPENTER

A bargain-counter installation of water turbines fails to come up to the guaranteed efficiency and precipitates a lively argument between the engineer of the plant and the representatives of the builders.

THE chief laid down his copy of *Power* with a smile and slid it across the big double-ended desk to Bill, his assistant.

"I see the big guns is at it again, tooth an' nail, this time it bein' over a mere trifle like findin' the total flow of a stream by means of velocity measurements. One gentleman says that another member of our learned profession is fulla soup, to put it mild, an' somethin' tells me they's gonna be blood, hair an' the ground tore up.

"It reminds me of the time when they put in the first turbines in this plant, some six years ago. We had a little time here then that would make a New York City mud-slingin' election green with envy. It seems that our president, a darn good drygoods dealer, got an idea to buy generatin' equipment the way he bought drygoods. He thought he saw in one company's bid a hand-me-down-suit marked 'Take me home for $11.88,' an' it took him just five minutes to do it. When that salesman walked out with the contract signed and with a check for one-third of the price in his pocket, I thought I saw a Baxter Street glint in his eye.

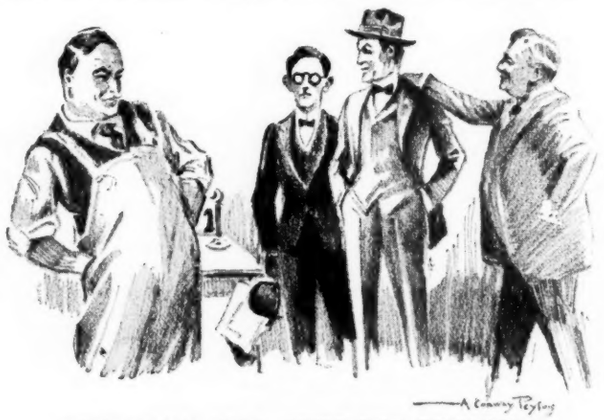
"It all went well until they got the turbines in and

"WELL, THROW IT OUT IF IT'S LAYIN' DOWN ON THE JOB!"

about three-quarter load on 'em. Then we opened the gates wide to get full load, an' to the surprise of everybody the ammeter needle didn't budge ten amperes. Our drygoods-store president was still struttin' around congratulatin' himself on what a good bargain he drove until he saw my face. He says, 'Whatsa matter, chief?' an' I pointed to the ammeter, it never occurrin' to me that that bird couldn't tell the time on that kind of a clock an' that he didn't know whether amperes is a new kinda grease or divvydends in embryo.

"'Well,' he snoozles, wavin' his fat hand, 'throw it out if it's layin' down on the job!'

"He got told that I'd darn sooner b'lieve that thing than lotsa preachers, an' he looks at me like I had rats in the attic. Them turbines," I says, "is doin' all of three-quarters of what they oughta, an' he asks if we can take 'em back and exchange 'em. After it percolated through his dome that it prob'ly would cost him about ten thousand to do it, he turned a sickish-lookin' green around the gills. Then the real fun began. I called the turbine company's man over to me an' told



"THEM BOYS, BILL, WERE THE ENGINEERS"

him to put full load on them turbines. He looked at the gate-openin' indicator, waltzed over to the meters, an' then beat it out on the bridge to see if they was any water comin' outa them draft tubes. They sure was. The discharge comin' outa them concrete draft tubes was the best-lookin' imitation of a spiral staircase that I ever did see, an' made you dizzy to look at it. Then he says that them turbines must be suckin' air an' I took off a manhole cover in the floor so he could squint down an' see them turbines purrin' like cats at liver.

"After he excused himself to go an' wire the office the glad tidin's, he didn't show up for a week. Then he brought up the heavy artillery, consistin' of a man an' two boys. He introduced the man to me as their sales manager; an' b'lieve me, Bill, all that that bird ever did here was to dictate five- and ten-page letters to the public stenographer at the hotel.

"Them boys, Bill, were the engineers. One of 'em I named Flossy right off the bat, an' that guy looked like he just throwed up a job posin' fer them collar advertisements in the trolley cars. The other gink was fastened at the nose to a pair of 42-centymeter shell-rimmed glasses an' prob'bly got 'em fer bein' a walkin' advertisement fer some optician who found that he had thirteen of that kind in stock an' gave him one to break the spell. I named him Omar, after the bird that wrote the Roobiyet an' cashed in over the problem of namin' a new cigarette.

"When them fellers got their circus clothes off, they went over the whole plant from the log boom down to a place a mile below the plant. They fin'lly comes to a decision that the whole trouble is because them contractors left a little colyum in the middle of each of them draft tubes fer fear that the beams inside was still a little green. They tells me that we can never expect to get any more power from them turbines because we got

them colyums there. But I noticed that they didn't seem to be crowdin' me to take 'em out.

"Their sales manager made a grandstand play outa that an' asks our president to call a special meetin' of the board of deerectors so he can tell 'em what's wrong, an' get 'em to vote to pay the balance of the contract. When they all got together, I was called in too. They was just an even dozen of us around the table, an' after the preliminaries was run, that sales manager got up an' addressed us in excellent Chinese. The way he talked to them trustin' deerectors about hyperbolic draft-tube curves an' the net total results of twenty years' tests on obstructions to flow by bridge piers was tearful. I betcha all the time he was readin' from some patent-medicine almanac, windin' up by hopin' that we would see the thing impartially an' keep the fair name of the great company he represented unsullied in these parts. Then he sat down an' hinted to Sam Scroggins that an adjournment was in order. But I gives Sam the high sign an' gits up on me hind legs. I said in plain Buckeye that I was darn sure that them colyums never eat up nothin' like a total of a thousand kilowatts an' offered to bet him a hundred iron men in the presence of all them there gentlemen, that if I cut out them colyums that we would'nt get more than a hundred kilowatts more for the whole plant at the contract head. That spilled the beans fer the day.

"His Nibs wasn't what you'd call crazy to take me up, but musta figgered that if he did lose that he could charge it to travelin' expenses or entertainment, so he fell fer my bait. A second thought told me that if I lost I'd have to put a plaster on the house to raise the coin. But the board told me to go an' use the best judgment I had, so I cut 'em out.

"Well, Bill, you oughta seen what happened. The night of the day that them contractors got through cuttin' out them colyums was a rather sleepless one fer me. I was wishin' to the Powers That Be that I bet that ribbon-counter sport it would be two hundred kilowatts more instead of one hundred; but the beans was spilled an' I had to face the music, an' maybe have that ballroom flower kid me about it, too.

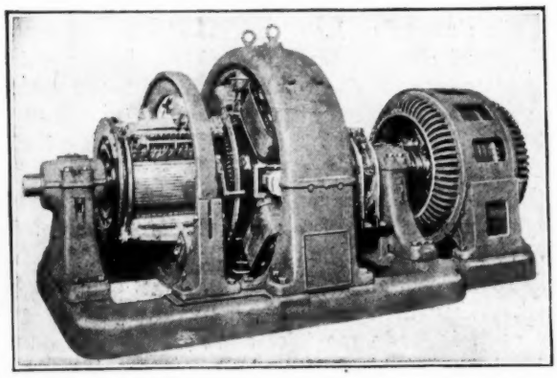
"The next mornin' I snuck down to the plant so early that I caught the night operator gettin' in his best licks at a beauty sleep. He jumped when he saw me like I was a spook, an' I told him to get back in his coop. I throwed all the load I could on one unit by cuttin' out the governor an' usin' the hand regulatin' gear to tear her wide open, lettin' the governor on the other unit take care of the load changes. With that riggin' I got what made 175 kilowatts better for the whole plant, an' me gettin' more an' more scared to death as I sees the needle climb. My hands had that cold, clammy feelin' so popular with corpses an' things like that, an' my voice was that cracked you'd 'a thought it was made of crockery. While I was still havin' them cold sweats, I takes a peep at the head gage; an' say! if Hop Sing, the laundryman, had been there I'd 'a fell on his neck an' kissed him! That gage showed two feet more head than the contract head, makin' a net gain due to takin' them colyums outa them draft tubes of fifty kilowatts! I felt so good after that that I went back to the night operator with the plaid hair an' big fam'ly, who thought he was fired sure, an' tells him with tears in my voice that I was surproozed at him, havin' no higher aims in life than to sleep when his trustin' boss was usually still in the clutches of Morpheus.

"Bill, after I collected that hundred offa that animated fashion plate, the turbine company put in new runners which gave way more than the contract power. Then it was the thing to find out if they got the contract efficiency. The company's engineers, Flossy an' Omar, made tests on the plant an' said that they got 5 per cent. more efficiency than the contract called for, makin' 85 per cent. The contract had the efficiency specified for the full rated load, so we were safe, an' which was 80 per cent. When the heavenly twins said that they got 85 per cent. it made me take another chew an' stew over it a bit. I fin'lly told 'em that we'd get another engineer to check their results before we paid the balance on the contract, an' it kinda got their goats, but they didn't let on. The next day I went an' got me a stop watch an' made some tests on me own hook that I could depend on.

"They is a stretch, as you know, Bill, about four hundred feet long below the plant that is tolerably straight, an' it ain't more than a hundred feet from the end of them draft tubes to the beginnin' of that stretch. Now that channel takes all the water from them draft tubes an' I'm pretty sure that they ain't no springs or other things runnin' into it. About half a mile above the plant there's a weir, an' with another below the plant, we was hooked up fine fer measurin'.

"I went and got me a good big float, weighted her down well an' saw that she went way below the center of the stream. Then I told a big buck nigger to throw the float in the stream while I stood down at the end of that 400-ft. stretch with the stop watch. When the thing was down in the water I clicked the stop watch an' timed it till it got down to me. Now, Bill, I got that coon to throw the float in at a different place every time, beginnin' with the left bank and workin' gradually over to the right bank, an' I got the time every trip. I was always careful to do this work when I was sure that the load was constant enough to have the work right, an' had the operator yell out if the governor moved much during the time I was measurin'. Finally I got a whole raft of timin' and I averaged the whole thing. From my dope on the distance an' the cross-section of the stream at a few places, you see I got the water quantity, but which had to be checked against the weir first. I have an old formula that says with a surface float I must use a constant of about 83 per cent. as a velocity coefficient, but with a subsurface float like I was usin' the constant is about 98 per cent. A table in a handbook was all I needed for the weir, and comparin' it with the float work showed that the coefficient was about 2 per cent. high, but that is of course assumin' that the weir is exactly right, which it ain't. The Francis formula for weirs gives results within 3 per cent. of the truth, accordin' to the best observers. Now, havin' the generator efficiency from the builders, it was easy to get the efficiency of the turbines. All I got was 78 per cent., while the contract called for 80 per cent."

(The remaining installment of this story tells how the stream flow was measured and checked by weir, float and current meter, and how the plant engineer proved that the turbines were not living up to the guaranteed efficiency.)



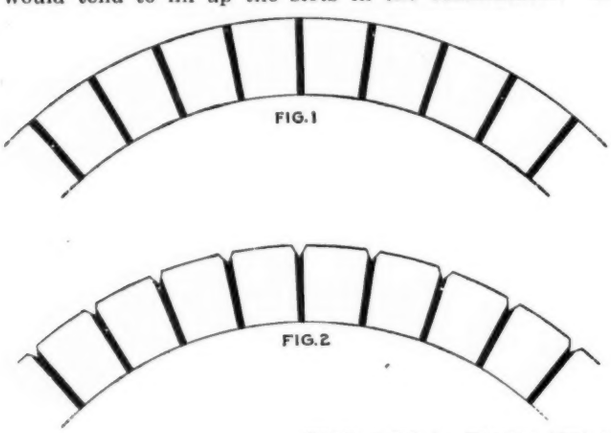
Application of Brushes to Electrical Machinery

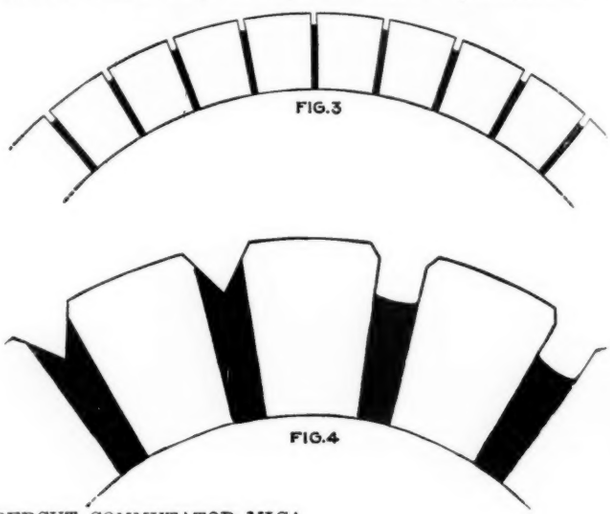
By WARREN C. KALB

In the application of carbon brushes the selection of the most suitable grade is frequently influenced by conditions peculiar to the service on which the brush is to be applied. Discussion of these conditions in relation to a few special fields of service gives an idea of some of the points that must be considered.

IN GENERAL factory service the characteristics demanded of brushes are determined more by the type of motor on which they are to be used than by any peculiarities of the service. In nearly all factory service undercutting of mica on the commutators is permissible and is strongly recommended. This permits the use of nonabrasive electrographitic brushes, which insures the longest brush life and the most satisfactory commutation service in every respect.

Ventilating motors usually operate at rather high commutator speeds and should be equipped with brushes possessing low coefficient of friction. The practice of undercutting commutators is to be recommended in this service except where the fans are used to exhaust heavy fumes of some nature or a dust-laden atmosphere which would tend to fill up the slots in the commutator. In such cases it may be advisable to use flush mica, as in Fig. 1, and a slightly abrasive brush.





FIGS. 1 TO 4. FLUSH AND UNDERCUT COMMUTATOR MICA

Motor-driven centrifugal pumps offer no special requirements provided the pumps are not overloaded. It frequently occurs that a pump is required after installation to deliver a head considerably greater than that for which it is designed or than that under consideration when the motor was applied. In such cases the motor may be heavily overloaded, and this factor must be taken into consideration in selecting the commutating characteristics and carrying capacity of the brushes which are to be used.

On motors driving reciprocating pumps, particularly where the gearing happens to be of such ratio that the end of the stroke always occurs when the brush is bearing on the same spot on the commutator, it is sometimes desirable to use a slightly abrasive brush even on motors with undercut mica, otherwise some spotting of the commutator is likely to take place in time.

The almost universal practice on electric railways at the present time is to undercut the mica of the commutators. By this means the need for an abrasive characteristic in the brush is largely eliminated. It also becomes necessary to avoid the use of a brush impregnated with lubricating treatment, as this material has a tendency to fill up the slots of the commutator, causing short-circuits and resultant armature trouble. Brushes can be rated considerably higher in carrying capacity for this service than for classes of service where they are in continuous operation over long periods. Probably 50 per cent. above the normal rating of a brush will give a satisfactory figure for carrying capacity under average electric-railway conditions.

The peripheral speed on railway motors is usually rather high, so that brushes for this service must have good lubricating property. They must also possess considerable mechanical strength and toughness to withstand the vibration they will be subjected to in this application. This is especially true when cars are operated over bad tracks or numerous crossings. The types of brushes now in general use for this class of service are the graphite-carbon class and electrographitic brushes.

Figs. 2 to 4 illustrate various forms of undercutting the mica of commutators. Where there is to be appreciable commutator wear, as is the case in railway service, the square slot, Fig. 3, is preferable. This

can be cut as much as $\frac{1}{8}$ in. deep for railway motors of high rotative speed where the centrifugal force is enough to clear the slots of most deposit. On lower-speed machines, however, the slot should not be of a depth greater than its width.

On machines that are operated in the presence of a large amount of dust, particularly if it is of a conducting nature, the V-type of slot, Fig. 2, is preferable, because it offers less of a pocket for the collection and holding of dust than is offered by the square type of slot. In all cases it is desirable that the corners of the commutator segments should be slightly beveled, as shown in the enlarged sections, Fig. 4. In the case of the V-slot this insures no edges of mica being left

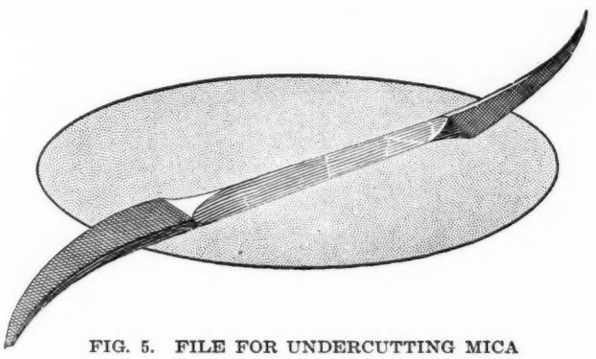


FIG. 5. FILE FOR UNDERCUTTING MICA

flush with the bearing surface of the commutator, and in the case of the square slot it is necessary to insure the removal of all burrs which might cause rapid wear of the brushes.

The undercutting of the mica may be done with various types of hand slotting tools. Where a V-shaped slot is required, the work can be successfully done with a commutator-slotting file similar to the one shown in Fig. 5. In many of the large shops a motor-driven tool is used, as shown in Fig. 6.

The requirements for generator brushes in steel-mill service are practically the same as those of any power plant, except where the presence of gases tends to corrode the commutator. In this case there is need of somewhat more polishing action in the brush than is required for a generator operating in clean atmosphere.

In regard to the motors about a steel plant, the rapidly increasing practice of undercutting mica in the commutators permits the extensive use of graphite-carbon brushes and the various electrographitic grades. In mills where the practice of undercutting has not been adopted, the carbon-graphite type of brush finds a general application.

Conditions about mines as they relate to the application of brushes are about the same as in steel mills, except that they are more severe in the average mine. This greater severity is due to a variety of conditions, among them being less stable mounting for the average machine, resulting in greater mechanical vibration, the presence of considerable moisture, which has a deteriorating effect on the insulation of the windings as well as preventing at times the undercutting of commutators, and the inferior class of help that will usually be found in charge of the electrical equipment of isolated mines as related to that about steel mills. Carbon-graphite and graphite-carbon types of brushes have an extensive application in this service, and the harder grades of electrographitic brushes give excellent results where commutators are undercut.

The peculiar condition encountered in cement-mill service, which distinguishes it from that in other industries, is the presence of an abrasive dust, which makes the use of a lubricated brush inadvisable. Slotting of commutators is permissible in cement mills provided the slotting is not too deep. The maximum depth to which it is advisable to undercut mica on machines that are operated in an atmosphere such as that found around the average cement plant is $\frac{1}{32}$ of an inch.

The use of an insulating varnish or paint in the slots of the commutator is recommended on motors that are to be operated under conditions where there is a possibility of the slots becoming filled with a conducting material. This practice will prevent short-circuiting of the armature and still retain all the advantages of the undercut commutator. The presence of the abrasive dust around cement mills makes possible the use of nonabrasive brushes on flush mica, in many cases where undercutting of the mica or the use of an abrasive brush would be required in other classes of service.

As was pointed out in the discussion of electrographitic and metal-graphite grades, the former type of brush possesses considerable advantage over the latter for collector-ring service under such conditions as are encountered in a cement mill, provided the current density in the brushes is kept within the range of the carbon brush. The increased slip of induction motors due to the use of the latter type of brush offers

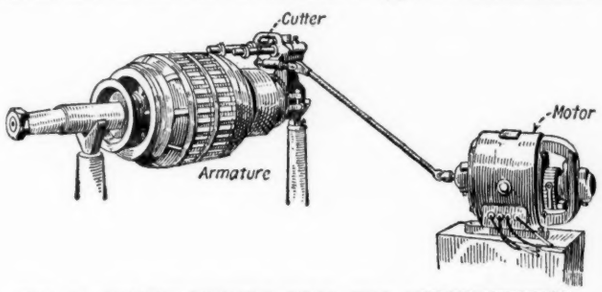


FIG. 6. POWER-DRIVEN TOOL FOR UNDERCUTTING COMMUTATOR MICA

no disadvantage in this case, as close speed control is not essential on the type of machinery used in this service.

The distinguishing characteristic of service about electrolytic and other chemical process plants is the corrosion of commutators due to the fumes from acids and other chemicals. Undercutting of the mica is advisable on all machines in such installations, and even with the mica undercut the use of a brush possessing some polishing or even a slight abrasive characteristic is advisable. Without undercutting it is often found necessary to use a brush of considerable abrasiveness in order to avoid high mica and the troubles incident thereto.

As is the case in electric-railway service, it is permissible to use a higher-current density in the brushes on elevator service than in continuous service owing missible to use a higher current density in the brushes is subject. One of the most important characteristics to be considered in the selection of a brush for this

service is quiet operation. Where elevators are used in hotels and apartment houses, a very slight brush noise from the motor may be the cause of considerable complaint.

A very low peripheral speed sometimes offers a more troublesome tendency for chattering than speeds that are quite high. This is just what is encountered on an elevator motor immediately after starting and just before stopping, and the task of securing a brush that will operate quietly at these speeds sometimes presents a serious problem. It is important that brushes used for this service must have a low coefficient of friction at low peripheral speeds, which is not true of all brushes that are adapted to high peripheral speeds. For special conditions such as this, it is well to consult the manufacturer of brushes in regard to the selection of a suitable grade.

In selecting a suitable brush for any particular application, an analysis of the operating conditions should be made along the line that has just been indicated and the general type of brush determined which is best adapted to the service conditions encountered. The peripheral speed of the commutator or slip ring on which the brush bears should then be figured as well as the current density within the brushes. The following formulas are of convenience in this connection:

Peripheral speed in feet per minute $= \frac{D}{12} \times 3.1416 \times S$, where D equals diameter of commutator or slip ring in inches, and S equals the speed in revolutions per minute.

Current density in amperes per square inch $= \frac{2I}{N \times W \times T}$, where I equals load on machine in amperes, N equals total number of brushes on machine, W width of brush in inches, and T thickness of brush in inches.

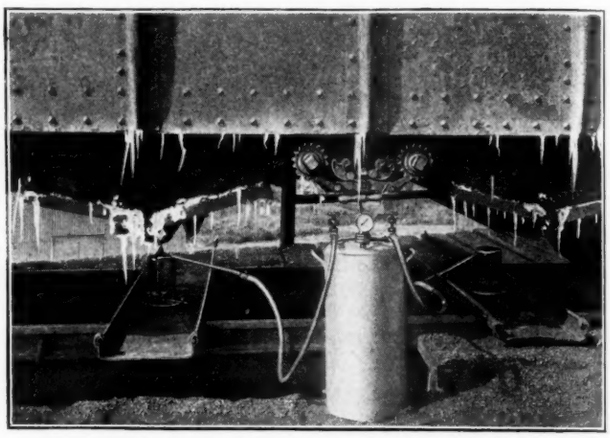
After making these calculations all grades recommended by the brush manufacturer for peripheral speed and current density below those to be met should be eliminated, except for conditions of service such as previously mentioned on railway and elevator motors, where brief periods of operation make it permissible to use current densities above those recommended for continuous service. If commutating conditions are severe, high-contact drop should be made the next essential. Knowledge gained by experience with various types of machines is of great assistance in determining this point, otherwise one must judge by the operation of the brushes on the machine and the fact of whether or not the machine has interpoles.

In general, machines with interpoles or compensating winding may be assumed to have better commutating characteristics than those without. Hardness need not be given much consideration in the selection of a brush unless in relation to quiet operation or to severe mechanical conditions. Abrasiveness, however, is an important characteristic and must be considered carefully in relation to the operating conditions. On undercut commutators little or no abrasiveness is required in the brush, while on commutators with flush mica some abrasiveness is needed in almost every case.

Experience with various grades is the best guide to selection as regards abrasiveness, in view of the fact that there is no unit by means of which brushes can be rated in this respect. As a result of the eliminations here outlined, final selection will probably be brought down to three or four grades. The description of these given in the literature of the brush manufacturer will probably offer the clue as to which is best adapted for the conditions of service under consideration.

Aeroil Thawing Outfit

It is sometimes difficult to remove coal from hopper-bottomed cars owing to the frozen condition of the hopper gate during severe winter weather. Engineers had ample experience with this trouble last winter. A handy device, known as the Aeroil thawing outfit and manufactured by the Aeroil Coal-Thawing Outfits, Inc., No. 1 Broadway, New York City, has been designed to meet the needs of those who receive coal in carload lots for a means of thawing frozen coal cars rapidly and at a minimum cost. The outfit is portable and can be placed under a car in a few minutes and shifted about as desired. The fuel used is kerosene oil, and the consumption is from 2 to 5 gal. per hour. The illustration shows the application of the device.



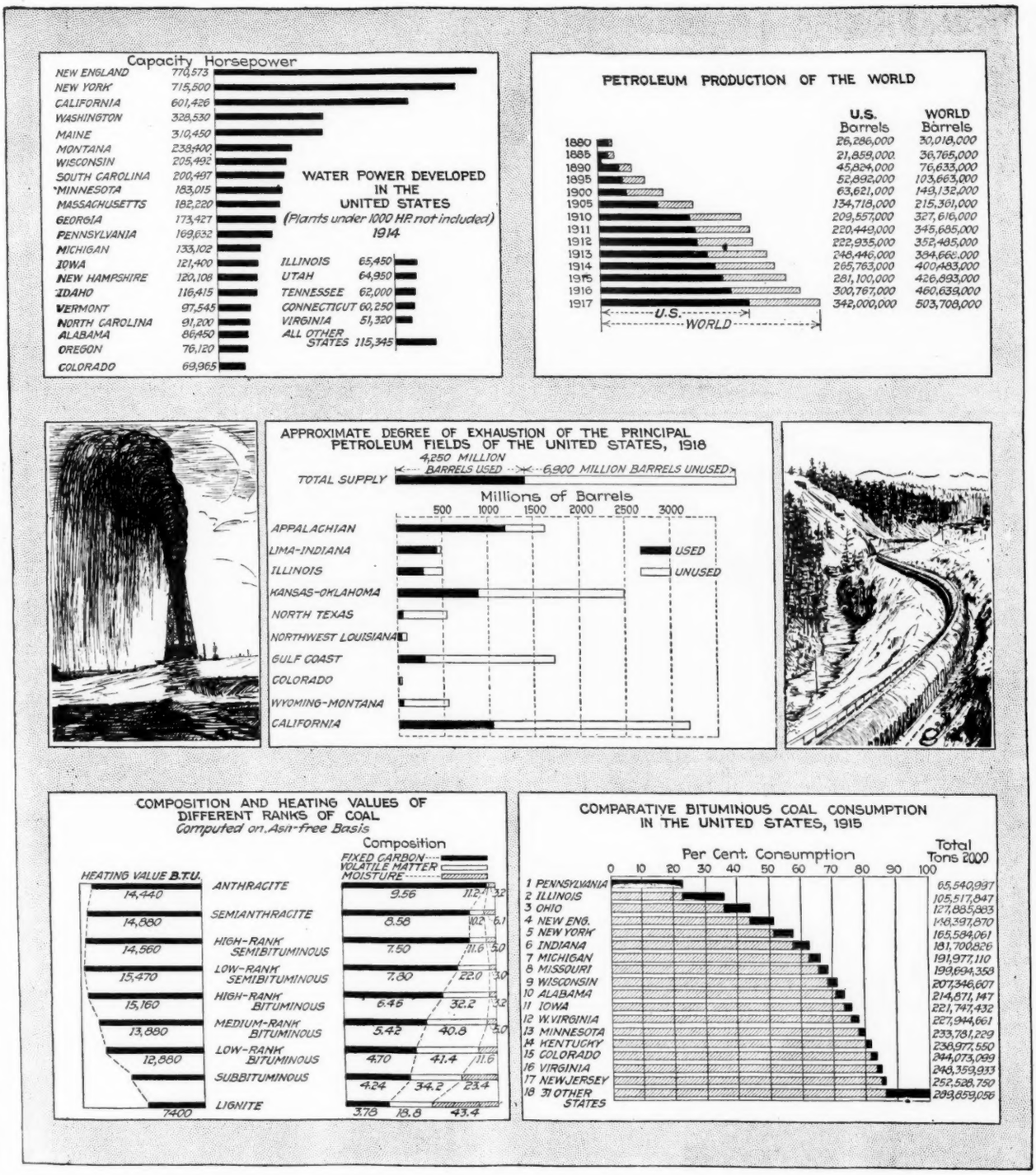
THAWING FROZEN COAL-CAR HOPPERS

The outfit consists of a 10-gal. tank equipped with a hand air pump, pressure gage, air release or regulating valve, and filling nipple with cap; two lengths of 8-ft. rubber hose with unions, two extension pipes with connections, and two thawing burners.

The flame can be directed at such a distance and in such a manner that only the hot air preceding the flame strikes the gate and surrounding woodwork, in case it is used.

No appliance about a power plant receives such lack of attention and such abuse as does the ordinary boiler-feed pump. It is put in an out-of-the-way place, and is generally in charge of a careless fireman who gives it no attention so long as it will pump the necessary supply of feed water. As the ordinary feed pump will consume a great many pounds of steam in the course of a year and as so much depends upon its reliability and continuous operation, it would seem that it would pay the chief engineer to place it in the care of some one who would be held responsible for its condition. If this were done, a vast improvement would result.

Coal, Oil and Water-Power Statistics

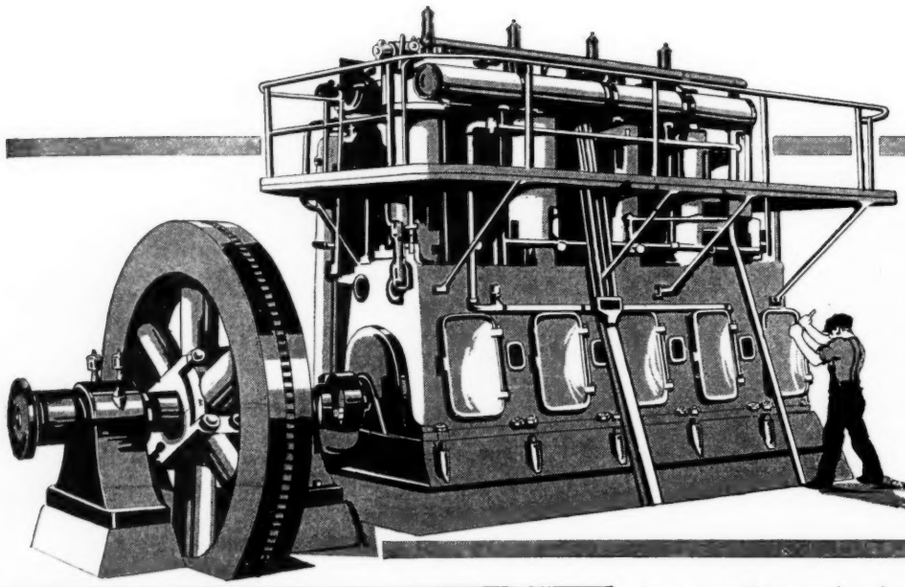


CHARTS SHOWING WATER-POWER DEVELOPMENT, COAL AND PETROLEUM PRODUCTION IN THE UNITED STATES

WHEN the next report of the Bureau of the Census is issued some time soon, it likely will show a material increase in water power, particularly for some of the Southern States. The water-power chart shown here was presented before the Pan American Scientific Congress. The chart giving the petroleum production of the world is from the National City Bank of New York. The others are by the Geological Survey.

It is of interest to note from the chart in the middle of the page that the exhaustion of petroleum has about reached one-half of the ultimate principal supply. Discovery of new fields may, however, seriously upset these figures. The figures do not, so far as can be determined, include oil deposits in shale.

The last chart starts with Pennsylvania, and each state is added to those preceding in the order of its consumption.



Talks on DIESEL Engines

by L. H. Morrison

VIII—The talk turns to a discussion of the various causes of cracked cylinder heads, and Egan tells a story with a dramatic ending.

"WHAT'S the subject for discussion tonight?" Kelly asked as the chief settled into his chair at the table.

"Cylinder heads," Egan answered. "It's one of those things that might be covered in a few words or expanded into a whole evening's talk. You can divide cylinder heads into two classes—the simple and the complicated. Here is a simple form, with a sectional view of it." He spread out the illustration shown in Fig. 1. "You can see it's free of irregularities that might cause shrinkage strains. This style is being largely adopted for vertical engines. The style shown in Fig. 2 is common practice in horizontal engines. It is easy to see why this one can't be symmetrical."

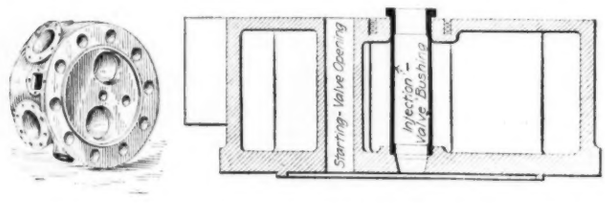


FIG. 1. CYLINDER HEAD FOR VERTICAL ENGINES

"It isn't so easy," Woods contradicted. "I don't get it, quite. Would you mind explaining why?"

"Not at all," replied Egan. "That's what we're here for. Now, you can see that if the valves are set in a vertical position the head cannot be as short as in Fig. 1. You must have room along the sides for the valves. If the compression is to be kept up to 550 lb., the clearance volume in the head cannot be large. Consequently the inner surface must be made conical in order to give room for the valves and still have a small volume of the combustion chamber." "Why not set the valves horizontal?" demanded Woods. "Too much wear on the stems," was Egan's prompt reply. "Even in a gasoline engine horizontal valve stems wear rapidly; but in a Diesel, where the pressure runs so high, the wear is much faster. And the result is that the valves do not rest central on their seats."

He paused a moment to relight his cigar.

"Getting back to complicated cylinder heads," he went on, "I don't think it's internal strains that crack them. It's my opinion that the cooling water gets into dead corners or pockets and becomes so hot that it deposits scale on the metal. The deposits at these points"—he indicated the points marked *A* in Fig. 2—"may become quite heavy. Under the alternate heating and cooling it is liable to loosen in a chunk and suddenly expose the hot metal to the cool water, with the result that a crack is developed. This isn't just a theory of mine. I know of more than one case where cracks occurred at spots that evidently had just been uncovered. The only way to prevent this trouble is to keep the scale from getting thick."

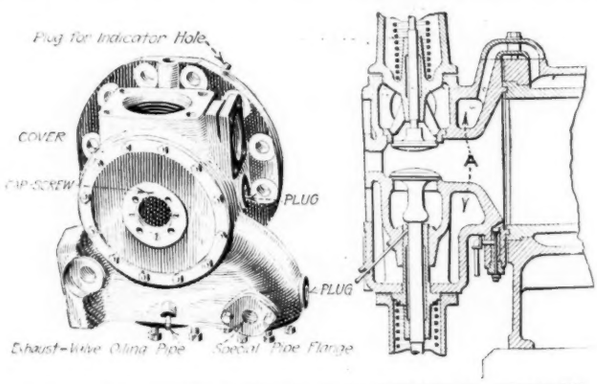


FIG. 2. CYLINDER HEAD FOR HORIZONTAL ENGINES

"Well," Kelly spoke up, "if the head has dead corners and the water has scale in it, hanged if I can see how it's possible to follow your advice."

J. R. laughed at this announcement. "It isn't impossible, by any means," he declared. "If the water is hard, all you need do is to put in a 1 per cent. solution of muriatic acid about once every month and let it stand for an hour. That will cut the scale.

The next article takes up the construction of inlet and exhaust valves and their cages

Don't let it stand too long, or it will attack the iron itself. Also flush out the entire water jacket every month with a soda-ash solution. At the Midvale plant the engineer mixes graphite with the cooling water to prevent deposits. I know the water at Midvale is bad, but the last time I was there the jackets and heads were clean, with no signs of scale."

"Why not use water softeners, like they do in steam plants?" suggested Woods.

"Now you've said a mouthful," Egan agreed. "That same thought has puzzled me. Here is our own company, supposed to be progressive, with 1500 hp. in Diesel engines, and yet it's impossible to get them to

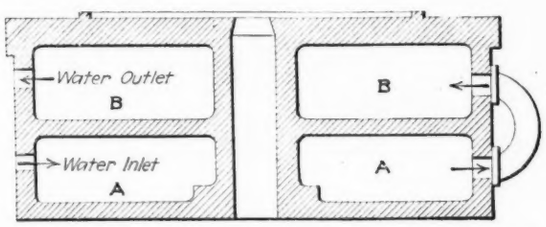


FIG. 3. DOUBLE CYLINDER HEAD WITH WATER CIRCULATION

consider a water-softening outfit, although the water is worse than in many steam plants." He flicked the ash off his cigar with an angry gesture. "The time is coming when the value of accessories will be recognized, and water-softening apparatus is one of them. It will cut repairs in half, reduce operating expenses and increase the plant efficiency."

"If all you said is true," argued Woods, "then the head of a vertical engine shouldn't crack. But I know of a couple that did, and I'd like to know why."

"That's like telling a horse doctor your mule is dead and asking him what the disease was," J. R. retorted. "I know a case where a vertical engine in a flour mill broke two heads, and it was due to a combination of ignorance and cold water. The mill operates on half load during the night and about 8 o'clock in the morning carries full load. The cooling water comes from an artesian well and is around 60 deg. F. Like our own vertical engines this one has the head cooled by a water line separate from the line feeding the cylinder jacket. From my observations I believe the engineer opens up the cylinder lines to a full flow as soon as the heavy load comes on. This water rushing through cools the head suddenly and it lets go, fracturing the wall between the exhaust-valve opening and a bolt hole. With such cold water the heads should be connected onto the jacket line. The water would be raised by the jacket to around 90 deg. and would enter the head cavity at this temperature, which would prevent the sudden chilling. A German firm got around this by using a double head like Fig. 3. The water first enters the chamber *A* and then passes into the chamber *B*. In this way the water next to the hot head is of fairly high temperature and the cold current in the chamber *A* helps to keep down the temperature in the chamber *B*."

"Well, what made that No. 1 American Diesel crack its head the first year I came here?" demanded Kelly.

"Let me sketch the way that head is built," said Egan. He quickly drew the section shown in Fig. 4. "Now this head connects with the cylinder jacket, and that is one reason there has never been a fracture due to the cooling water. The cause of fracture is the lack of cooling at the exhaust bridge *A*. The hot exhaust gases must pass across this thin iron partition, or bridge, and it expands faster than the rest of the head. Since the head is rigid, the bridge bulges up and when the engine is stopped the bridge cools off and snaps as it cools."

"Kelly was telling how you welded that head, but he was a little hazy as to why you heated it. I wish you would explain that," Woods remarked.

"Well," said Egan, "we had made several attempts to weld the head with an oxyacetylene blow torch, but for some reason the bridge always snapped when it cooled after welding. I decided that this was because the bridge was hot while the remainder of the head was still cold. So I made a furnace out of old grate bars, firebrick and blocks, heated the head until it was red-hot, welded the fractured bridge and let the casting cool. The bridge came out in fine shape. Of course the welding ruined the exhaust-valve seat, so we blocked the head, bored out the seat, and finished it up with a valve-seat reamer. This same process could be used to weld any head. I don't believe it's necessary to discard a fractured head. A new head on an 18-in. cylinder would probably cost five hundred dollars. The entire cost of welding would not exceed a hundred dollars, and the welded head would be stronger because the shrinkage strains would be removed."

"But, Chief," Kelly asked, "is poor circulation the only thing that will cause broken heads?"

"Not at all," answered Egan. "Preignition will do it. If combustion begins before dead-center is reached, the

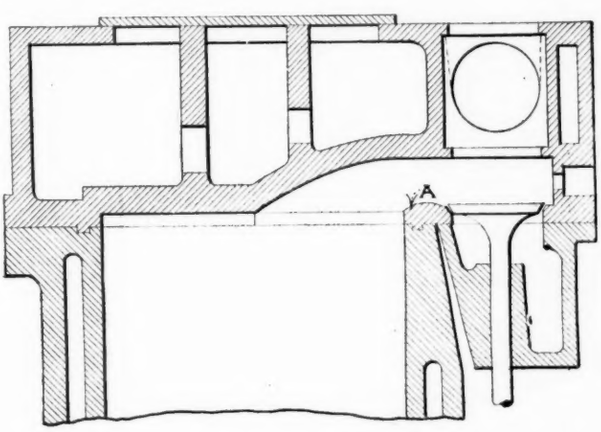


FIG. 4. EXHAUST BRIDGE CRACKED BECAUSE OF INSUFFICIENT COOLING

combined effect of the combustion and the compression due to the piston movement may run the pressure up to 1500 lb. per sq.in. The earlier Diesels had relief valves that prevented excessive pressure, but they usually rusted to their seats and refused to budge when they should have acted. None of the engines I'm familiar with have relief valves now, because builders have found that preignition is due to faulty fuel nozzles and poor governing devices. Then, again, a bad casting may cause a fracture—for instance, if a core shifts and leaves a thin wall. But poor water circulation is the chief cause."

He smiled reminiscently, and the men saw that a good story was coming.

"I remember a case," J. R. went on, "where a man had a 120-hp. horizontal Diesel running a direct-current lighting plant 18 hours a day in a small town. At midnight he'd close down the plant and go to bed, letting the town get its light from the storage battery. In the morning his boy would start up and run the plant until noon, when the old man would get up and work until midnight. It seems he broke three heads in a year and was kicking hard against paying for them. The builder asked me to investigate the matter, so I ran down one night and early the next morning dropped into the plant just as the boy was starting up. He ran the engine for about twenty minutes before he thought of the cooling-water pump. I came on back and wrote the firm that they'd soon get an order for another head, which they did. So they asked me to run down and tell the old man his trouble. After I explained about the boy's carelessness, the old man picked up a barrel stave and waded into that sixteen-year-old kid for fair. It cured the boy—and it cured the engine, too, for there weren't any more cracked heads."

J. R. was forced to wait until the roar of laughter had died out before he could continue.

"All you boys know how I insist that the cylinder studs have clean threads so that the nuts will run down by hand. I expect at times you've thought the 'old man' a crank about this. But if the nuts can be run down by hand, I'm always sure that the head is being held down at all the studs. When the threads are marred often only a few nuts are ever pulled up snug and so the head never seats properly. At one of the other plants, the nuts at opposite ends of a diameter are drawn up together, a sixth of a turn at a time, so as to get the same tension on all bolts. It's worth trying here."

The Electrical Study Course—Shunt Balancer Sets for Three-Wire Systems

Brings out the fact that balancer sets and three-wire generators have superseded two generators in series for three-wire supply systems and develops the theory underlying the operation of the balancer-set method.

IN THE preceding lessons the sources of voltage for three-wire systems have been shown as two generators of about 120 volts each, connected in series, with a tap taken off their common point, as indicated in Fig. 1. This method was the one used in the early days of power distribution, but it has been supplanted by two others, which are the ones in common use today. One of them employs what is known as a balancer set, and the other a special generator known as a three-wire generator. Of these the former will be taken up in this and succeeding lessons, to be followed by the latter subsequently.

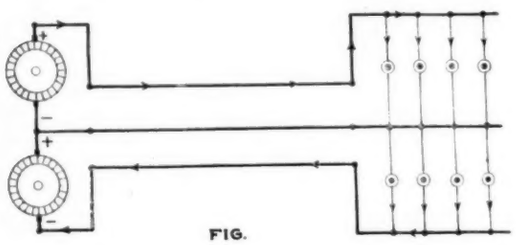


FIG.

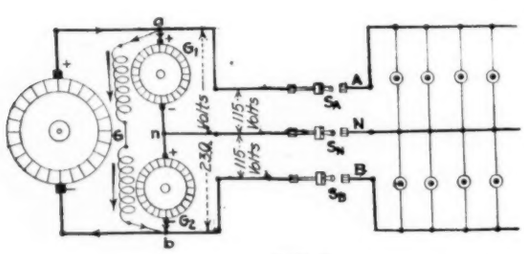


FIG. 2

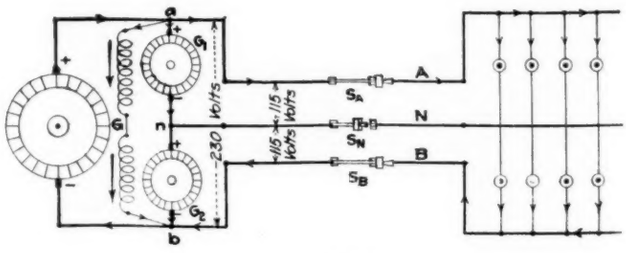


FIG. 3

FIGS. 1 TO 3. DIAGRAM OF CONNECTIONS FOR THREE-WIRE SYSTEM WITH BALANCED LOAD

The balancer set consists of two identical machines, which can operate equally well as motors or as generators, and which are directly coupled together. They are used in connection with a separate supply of voltage that is equal to what is required across the outside lines, the voltage of each of the balancer machines being equal to one-half this; that is, the voltage between either outside and the neutral.

The simplest arrangement is the one shown in Fig. 2, which represents a 115- to 230-volt system. In it G is a 230-volt generator, and G_1G_2 are two 115-volt shunt machines that are alike in all particulars. The generator G may be far removed from the balancer set G_1G_2, which may be located near the place where the three-wire service is required. Thus, the 230-volt supply may be received from some outside service, and the balancer set installed to make a three-wire system available from it. From the diagram it is apparent that the balancer set really consists of two 115-volt machines connected in series across 230 volts, with their common point n connected to the neutral N and their other terminals connected to the outside lines A and B.

The function of the set is to maintain normal voltage—that is, 115 volts—across each side of the circuit at all times and thus provide a true three-wire system. The theory of operation will be made clear by comparing the conditions existing in the machines while the load is balanced, with those when it is unbalanced.

Suppose, first of all, that the switches S_A, S_N and S_B, Fig. 2, are open, and that the machines G_1 and G_2 have been started as motors connected in series, from the 230-volt mains. Also that the excitation of the two machines is exactly the same so that the voltage across an will be the same as across nb. Since the voltage across ab is 230 volts, that across an and nb must therefore be $230 \times \frac{1}{2} = 115$ volts, and the current through both armatures will be the same and will be in the direction of the arrows.

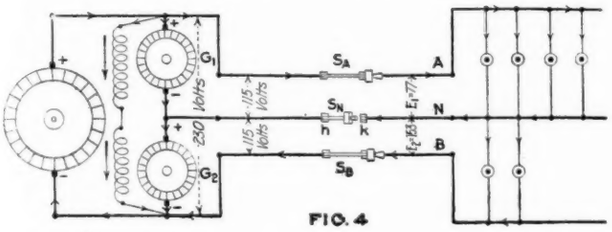


FIG. 4

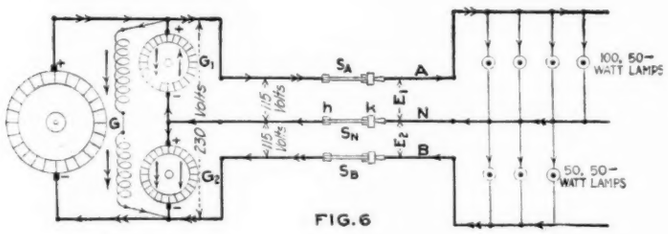


FIG. 6

Assume now that switches S_A and S_B are closed, but S_N left open, as in Fig. 3. If the lamp load is evenly balanced, the voltages from A to N and N to B will have the same value and will be equal to half the voltage across AB; namely, 115 volts. Under these conditions there will be no difference in voltage across the terminals of switch S_N, and if it were to be closed no current would flow in the neutral N.

Next let us assume that the lamp load is *not* evenly balanced while switch S_N is open, as in Fig. 4; then the voltage across AN will be different from that across NB. This can be most readily shown by a numerical example. Thus, if there were one hundred 50-watt 115-volt lamps across AN and only fifty across NB, we would have the following conditions: The resistance of each lamp would be equal to its current divided into the voltage, that is, $R = \frac{E}{I}$; to find I it would be necessary to divide the voltage into the watts input, that is, $I = \frac{W}{E} = \frac{50}{115} = 0.435$ ampere. From this $R = \frac{115}{0.435} = 264$ ohms. Since there are 100 lamps in multiple across AN, the resistance connected across these mains would be the resistance of one lamp divided by the 100, or $\frac{264}{100} = 2.64$ ohms, and similarly the resistance across NB would be $\frac{264}{50} = 5.28$ ohms.

We would now have the condition illustrated in Fig. 5, in which R_1 represents the resistance of the lamps between AN and R_2 that of those between N and B. The voltage across AB is 230 volts. The question is. What are the voltages E_1 and E_2 across AN and NB respectively? If I is the current flowing through R_1 and R_2, we will have $E_1 = IR_1$ and $E_2 = IR_2$. To find I we divide the resistance between A and B into the voltage across them, which gives $I = \frac{230}{2.64 + 5.28} = 29$ amperes approximately. We therefore have $E_1 = 29 \times 2.64 = 77$ volts and $E_2 = 29 \times 5.28 = 153$ volts. The voltage of G_1 is therefore greater than that across AN, whereas the voltage of G_2 is less than that across NB, as shown in the figure. The difference in both cases is the same; that is, $115 - 77 = 38$ volts and $153 - 115 = 38$ volts. This voltage will exist across the two sides of the switch S_N, and a voltmeter connected to h and k in Fig. 4 will read 38 volts, consequently current will flow through the switch when it is closed.

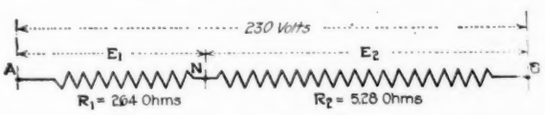


FIG. 5

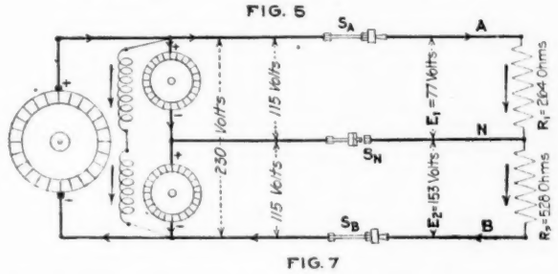


FIG. 7

FIGS. 4 TO 7. DIAGRAM OF CONNECTIONS OF THREE-WIRE SYSTEM WITH LOAD UNBALANCED

To study the direction and value of the current reference will be made to Fig. 6. The double arrowheads indicate the direction of the current when switch S_N is open as in Fig. 4. The single arrowheads represent the direction of currents existing when switch S_N is closed. Since A is positive with reference to N and since E_1 is less than 115 volts, it follows that when switch S_N was open the side k was at a higher voltage than the side h, consequently when the switch was closed current would flow from k *to* h. The same deduction would follow if the voltage E_2 were considered instead of E_1; here N is positive with regard to B and E_2 is greater than 115 volts. Hence again, k is at a higher voltage than h.

Before the switch S_N is closed, both G_1 and G_2 are running as motors without load and 115 volts exist across each of them, as in Fig. 4. When the switch is closed, we have G_1 connected to a load whose voltage is only 77 volts and it will consequently act as a generator. On the other hand, we have G_2 connected to a voltage of 153 volts, and it will therefore be caused to take current in addition to that required to run it idle. The changes in currents are governed by the elements as brought out in what follows:

Fig. 7 is a simplified version of Fig. 6, using the equivalent resistances of Fig. 5 in place of the lamps. Assuming, for the moment, that the voltage of both machines remains 115 volts when the switch S_N is is closed, it is evident that the voltage across R_1 changes

from 77 to 115 volts and consequently the current through it will be $\frac{115}{2.64} = 43.6$ amperes instead of 29 amperes as formerly, and similarly that the voltage of R_2 changes from 153 to 115 volts, making its current $\frac{115}{5.28} = 21.8$ amperes instead of 29 amperes. As a matter of fact, however, the voltages cannot remain at 115 volts as they would in the case of an automatically controlled generator and a motor connected to a sufficiently large supply line. When G_1 is converted from a motor into a generator by the closing of switch S_N, its terminal voltage is reduced due to the load upon it, and is therefore less than 115 volts. Since G_1 is running as a generator, it follows that it must receive mechanical power from some source, which in this case is machine G_2. That is, G_2 running as a motor drives G_1 as a generator, and it would therefore tend to slow down, but since the voltage across G_1 is somewhat less than 115 volts, the voltage across G_2 must be as much greater than 115 volts and it will therefore tend to speed up, thus counteracting the tendency of the load upon it to slow it down.

Putting this another way, it may be stated that when switch S_N is closed machine G_2 is thrown in parallel with the lamps from N to B and in series with them from A to N. Then part of the current required by the excess lamps connected from A to N flows along the neutral and through the armature of machine G_2, causing it to have a greater current through its armature than G_1, consequently machine G_2 increases in speed and with it G_1. The counter-voltage of G_1 is made greater than its applied voltage and it becomes a generator supplying a portion of the excess current required by the lamps between A and N. The flow of the current is indicated by the single arrowheads, Fig. 6.

Since both machines must always run at the same speed whatever that speed may be, and since their field currents are the same, it follows that their generated voltages must be practically the same. The generated voltage of the motor G_2 is its counter-em.f. The terminal voltage of the generator G_1 will be its generated voltage minus its internal voltage drop due to armature resistance. Likewise the terminal voltage of the motor will be its counter-em.f. plus its resistance drop. If the load between N and B is made greater than that from A to N, then machine G_1 acts as a motor to drive machine G_2 as a generator.

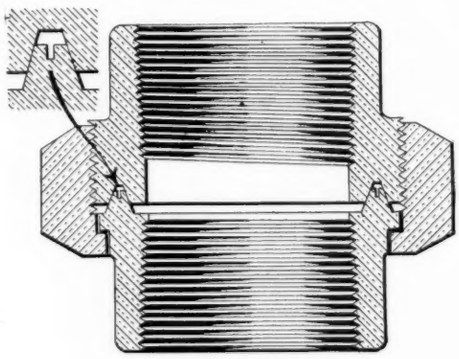
In the problem of last week it was required to find the size wire that it would be necessary to install in a three-wire system that is to supply current to a load of 46 kw. at 115 volts. Since half the load is on each side of the system, there would be a load of $\frac{46}{2} = 23$ kw. between each outside wire and neutral. The number of watts would be $1000 \times 23 = 23{,}000$, and the current equals the watts load divided by the voltage, or $\frac{23{,}000}{115} = 200$ amperes. Looking up the size wire required for this current, as given in the National Code, we find that we would have to use a No. 0000 wire if rubber covered, or a No. 0 if other insulated wire is used.

A 115- to 250-volt three-wire system is loaded with thirty-two 20-watt 115-volt lamps on one side and with twenty-four on the other. What would be the current in each of the three supply wires? Suppose a break to occur in the neutral line, what would be the current in the outside wires and what would be the voltages across the two sides of the system?

Edward Gasketless Double-Tight Union

Troubles with leaking flange gaskets in pipe lines are common. A letter in the Nov. 26 issue of *Power* described how such a joint was made tight by turning a tongue and groove on the faces of the flange, the metal-to-metal joint being made at the heel of the tongue.

A similar idea is found in the Edward gasketless double-tight union, manufactured by the Edward Valve and Manufacturing Co., 72 West Adams St., Chicago, Ill. The illustration shows the construction. It is made somewhat similar to the ordinary type of union, with the exception of the contact joint. One face is grooved V-shape, and the other is made with a



GASKETLESS UNION

split tongue. The faces of the tongue and groove are made with about 2 deg. difference of angle, and the joint is made at the narrow part of the V-groove, which gives a somewhat flexible joint.

No gasket or inserted seat is used with the union, and the joint is made doubly tight because of the two separate independent contacts of the split tongue in the groove.

Omaha is contemplating city ownership of its gas plant. The franchise of the present gas company expires soon, and a condemnation court has been appointed to make an inventory and appraisal of the plant. Omaha's water-works system has been municipally owned for six years, and the rate has been reduced about 60 per cent., with excellent service. This has encouraged the city to look toward another municipally owned undertaking.

The quantity of crude petroleum marketed from oil wells and field-storage tanks in the United States in 1918 reached the record-breaking total of 345,500,000 bbl., as shown by preliminary estimates made by John D. Northrop, of the United States Geological Survey, Department of the Interior. This output is an apparent gain of 3 per cent. over the former high record, 335,315,601 bbl., established in 1917.

Water Circulation in Boilers*

By A. D. WILLIAMS

Interesting points are brought out regarding the water circulation in water-tube boilers. Experiments are cited by which the observer can obtain a good idea as to the flow of steam in the tubes with varying degrees of pitch.

OWING to the fact that water may be converted into vapor at rather low temperatures, there is no particular difficulty in constructing a boiler that will produce steam when heat is applied to it. Today there are so many different designs that it would be difficult to enumerate them. A few years ago boilers were operated and rated at the nominal figure of 10 sq.ft. of heating surface per boiler horsepower. Today the nominal rating remains the same, but in practice the boiler is operated at from 150 to 300 per cent. of rating. The water-tube boiler was devised to increase boiler efficiency by securing improved water circulation and breaking the circulating water up into multiple streams surrounded by hot gases. In this they have met a certain degree of success as is proved by the modern method of boiler forcing.

The most widely used design of the water-tube boiler consists of one or more steam drums and an assemblage of inclined tubes, the pitch or slope varying from 8 to 30 per cent. These tubes are generally arranged in multiple, but there are designs that employ series operation of a number of multiple banks of tubes. Circulation generally depends upon the thermal siphon principle; that is, upon the hydrostatic head developed by the difference in weight of two columns of water of slightly different temperatures. Additional circulating velocity is supposed to come from the fact that one of these columns of water is solid and the other partly displaced by steam bubbles.

The accompanying table shows the weights of water and steam at different temperatures, by 20 deg. C. increments, together with the corresponding pressures. At the boiling temperature, 100 deg. C., the ratio between the weights of equal volumes of steam and water is

WEIGHT OF WATER AND STEAM AT VARIOUS TEMPERATURES

			Weights of				
Temperature, Deg. C.	Steam Pressure Kg. per Sq.Cm.	Lb. per Sq.In.	(Water) Lb. per Cu.Ft.	Water Kg. per Cu.M. Ounces per Cu.Ft.	Steam Kg. per Cu.M.	Lb. per Cu.Ft.	Ratio of Weights. W ÷ S
0	0.00623	0.0886	62.492	999.87	0.00485	0.000303	206,158
4			62.500	1000.00			
20	0.0238	0.338	62.389	998.23	0.0173	0.00108	57,701
40	0.0749	1.066	62.016	992.25	0.0511	0.00319	19,517
60	0.2028	2.885	61.453	983.24	0.1305	0.00815	7,534
80	0.4828	6.867	60.739	971.83	0.2938	0.0183	3,307
100	1.0330	14.690	59.899	958.38	0.5980	0.0373	1,602
120	2.0240	28.790	58.963	943.40	1.1220	0.0700	841
140	3.6840	52.390	57.900	926.40	1.9680	0.123	471
160	6.3000	89.590	56.719	907.50	3.2650	0.204	278
180	10.2160	145.30	55.413	886.60	5.1500	0.322	173
200	15.8400	225.20	53.925	862.80	7.8400	0.489	110

about 1 to 1600, which is sufficient to supply an ascensional velocity to the steam of about 580 ft. per sec. At 200 deg. C. the ratio drops to 1 to 110 and the ascensional velocity to 153 ft. per sec. The coefficient of friction between the bubble of steam and the surrounding water is unknown, but even if an extremely liberal allowance is made for this coefficient and for the viscosity of the hot water, the steam bubble will rise above any moving stream of water circulating through a tube before it can be carried any great distance horizontally.

A simple experiment will permit the verification of the foregoing statement. A glass test tube is nearly filled with water and a smaller tube is used to blow air so it will bubble up through the water. A cork with a vent on one side and a hole for the smaller tube permits the test tube to be inclined to various degrees. The ratio between the weights of equal volumes of air and water is 1 to 774. (When the tube is inclined the vent should be at the upper side, otherwise the apparatus will backfire.) Upon blowing through the small tube it will be found that at the vertical position and at slight inclinations from the vertical, the air will rise in bubbles. This action is utilized in the air lift used in raising water from deep-driven wells. When the degree of inclination approaches the horizontal, there will be a tendency for the stream of bubbles to follow the high side of the tube, and a stream of air can be formed. The less the pitch of the tube the easier it is to maintain this stream of air. This would lead to the conclusion that in the inclined tube design of water-tube boiler the lowest portion of the tube would be filled with water for its full area and at its highest portion the tube would have the lower part of its area filled with water and the upper part filled with steam.

Action Is Complicated by the Baffling

In the boiler, however, the action is complicated by the baffling and the portion of the tube exposed to the hottest gases. With the ordinary method of baffling used with the B. & W. type of boiler, the high end of the tubes is exposed to the hottest gases and this end therefore will be filled partly with steam and partly with water. When the lowest portion of the tube is exposed to the hottest gases, there is a tendency for a portion of the steam generated to pass from the tube to the rear header and up to the steam drum. This action may be avoided by bushing down the rear end of the tube and in this manner increasing the velocity of the water entering to an extent that will enable it to carry the steam with it to the front header.

An experimental single-tube boiler may be extemporized from a gage-glass, a wooden clamp arranged to hold the tube at various degrees of inclination, two pieces of rubber tubing fitted to the ends of the gage-glass and connecting with nozzles on the bottom of a tin pail, a bunsen burner or a blowtorch. The pail should be partly filled with water and supported so that there is space below it to permit the gage-glass to be brought nearly vertical. The heat can be applied to different parts of the water tube and held there until steam begins to form. The evidence of convection currents may be obtained by dropping a few crystals of potassium permanganate in the water near the down leg. As this slowly dissolves, a stream of pink will show the direction of the current. If the water is colored a light pink, it will, in the steaming tests, permit

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the steam bubbles to have a higher degree of visibility. When the heat is applied at the lower end of the slightly inclined tube, it will be found that a portion of the steam goes up the down leg instead of the up leg. As the inclination of the tube is increased, this tendency decreases until all the steam tends to flow to the up leg and this greatly increases the velocity of circulation. A neat modification of this one-tube boiler has glass up legs and down legs of various lengths, with only short rubber connections between the tubes and to the pail. A number of interesting experiments may be conducted with this simple apparatus, and in this way a better idea of the conditions governing water circulation will be obtained.

Steam Has Fractional Value

The specific heat of water and its heat capacity are unity. The heat capacity of steam has a fractional value, but in contact with water, under the conditions existing in a boiler tube, it has reached the limits of its heat-absorbing capacity for the existing temperature. That is, any additional heat imparted to the steam in the tube will be immediately absorbed by the vaporization of a corresponding amount of the water present. When the water is converted into steam, its volume increases from 110 to 1600 times and it displaces from 109 to 1599 additional volumes of water.

The 4-in. boiler tube has a sectional area of 12.56 sq.in. Its length is about 18 ft. and its heating surface is 18.6 sq.ft. When a boiler is driven at 200 per cent. rating, it is evaporating water at the average rate of 0.29 oz. per 10.764 sq.ft. per sec. On this basis each tube will evaporate 0.49 oz. of water per second, on the average. However, it is not unreasonable to suppose that the lower tubes, directly exposed to the hot gases and radiant heat from the fuel, will have an evaporation rate of, say, ten times the average, or 3.94 oz. of water per tube per second. At a steam temperature of 200 deg. C. this would mean that about 35 per cent. of the internal volume of the tube was occupied by steam. At lower steam temperatures the volume of the steam released will be much greater and fill a larger percentage of the tube volume. It is probable that the lower end of the tube will be occupied by solid water, and if this is the case and the steam is generated uniformly the full length of the tube, 70 per cent. of the area of the highest end will be occupied with steam. Assuming that the pitch of the tube is 30 per cent., this is sufficient to give a head that will impress a velocity of about 18.6 ft. per second on the steam. Friction against the water surface may be either negative or positive, depending on their relative velocities. Friction against the tube surface will reduce the steam velocity.

The Absorption of Heat

The steam in the upper section of the tube will not be able to absorb heat as rapidly as the water in the lower section, but as long as a portion of the perimeter of the tube is covered with water there is no danger of the tube becoming overheated. The hydrostatic head causing the flow of water into the tube will be due to any difference of temperature between the front and rear tube headers and the height of the water column above the tube. Some experiments have indicated that this velocity decreases as the boiler is forced above rating.

Should the flow of water be interrupted, it will require only a few seconds for the tube to become full of dry steam; it would then rapidly heat until it burst. This would throw full boiler pressure against any slight obstruction and immediately remove all evidence of the cause of the trouble. With tube pitches less than that assumed, the liability to interruption in the water circulation increases. The slight differential head that exists through a tube might readily be sufficient to hold a piece of loose scale over the end of a tube and be insufficient to break it. That is, a very slight obstacle would suffice to stop the flow of water or so reduce it that a considerable portion of the tube surface would become dry.

Another reason that may cause burst tubes would be when the boiler is forced to such an extent that the water inflow into a tube becomes insufficient to provide for the evaporation taking place. This last condition would be more likely to occur in a clean tube, free from scale internally and from dust externally, than in a dirty tube.

Water Circulation Enhanced by the Effect of Steam Bubbles

When the boiler tubes are vertical or nearly vertical, the water circulation will be enhanced by the air-lift effect of the steam bubbles. Like the air lift, this is a problem that involves so many uncontrollable variables that it is doubtful whether any rational expression for this circulation will ever be worked out. The investigation of this circulation, however, will throw considerable light upon the rational design of steam boilers. It is very possible that a modification of the design of the Niclausse boiler having the field tubes set vertically, with the manifold at the top, will offer almost unlimited forcing possibilities, greatly exceeding the evaporative capacity of existing designs. Such a design, with an internal tube in each water tube, would be extremely difficult to clean. In any design to secure increased circulation it is rather important that the course of the water and of the steam bubbles should be arranged in such a manner that they will not impede each other. Theoretically, there should be no limitation to the amount of forcing which a vertical-tube boiler can stand except the heat-absorbtion capacity of its heating surface. With inclined tubes the boiler can be forced only to the extent of turning a sufficient amount of water into steam to occupy the full area of the hottest tubes at their highest point. Any further forcing with this type of boiler will cause it to destroy itself.

Exactly what the last word in boiler design will be is hard to say. Present designs leave much to be desired, not only in the circulation of the water but in the manner in which the hot gases pass through the setting and come in contact with the heating surface. The ruling temperature of boilers is very low. Convection currents in water are set up with very low temperature differences, and as the temperature of the mass increases the convection head caused by one degree difference in temperature increases. These physical principles do not cause design difficulties, and it is probably for this reason that boiler engineering has settled into a rut and the mechanical details of the connections entirely overshadow the importance of increasing its heat-absorbing capacity.

Vacuum Trouble in Turbine Condensers*

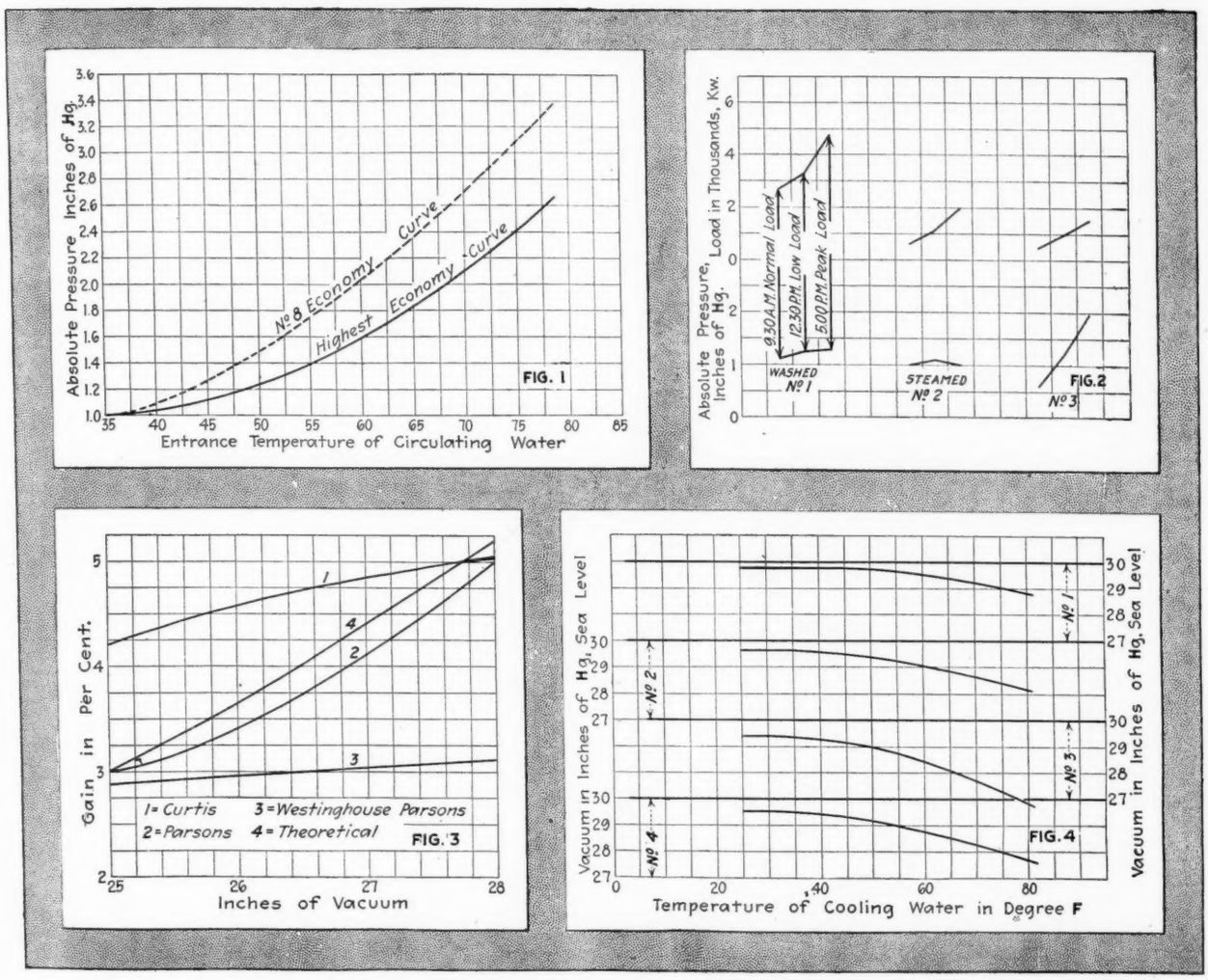
By JAMES BRAKES, Jr.*

IN THE article, "Keeping Up Condenser Performance," on page 868 of the Dec. 17, 1918, issue, H. LeH. Smith has, in his Fig. 1, plotted absolute pressure against the entrance of the intake circulating-water temperature. Notice that when the temperature of the water is 37 deg. the absolute pressure on No. 5 condenser is 1.18 in. while the pressure on No. 3 is 2.08 in. The former pressure corresponds to 28.8 in. and the latter to 27.9 in. of mercury vacuum referred to 30 in. barometer at 58.4 deg. F. temperature. This gives a difference of 0.9 in. vacuum, which is a considerable variation.

It is necessary that a condenser be overhauled and washed out frequently—at least once every two weeks. The pipe joints and stuffing-boxes should be tightened about the air pump and also the circulating pump. It is a fact that handling air in solution is the smallest percentage of work done by an air pump. The leakage through piping, etc., imposes the greatest duty. The amount of air ranges from ten to thirty times the amount that is dissolved in ordinary water.

On a performance test made by the Turbine Committee of the National Electric Light Association on a 5000-kw. Curtis turbine of the Boston Edison Co., the following is noticeable: The loads on test Nos. 2 and 3 were 3410 and 4758 kw. respectively, with a vacuum of 28.7 and 28.6 in. of mercury. The barometer reading was 29.95 in. A difference of 1348 kw. made a difference of 0.1 in. in vacuum. No doubt the condenser was washed previously to the test, hence the variation of vacuum was due to a great extent to the difference in load.

The writer has an idea that in the case mentioned in Mr. Smith's article the variation in vacuum on turbine condensers Nos. 3 and 5 was due to a drop in the load, air leak or erroneous reading. This is stated, provided the condensers are of the same type and the machines are of the same capacity. No doubt when Mr. Smith asserted that the highest possible plant



FIGS. 1 TO 4. CHARTS SHOWING CONDENSER PERFORMANCE

Fig. 1—Plot of readings on condenser No. 8. Fig. 2—Curves showing low, normal and peak-load readings. Fig. 3—Percentage of gain in economy per inch of vacuum for various vacuums. Fig. 4—Curves of condenser performance under different conditions

*Testing Department, Commonwealth Edison Co., Chicago, Ill.

economy was obtained on the best of the readings, he took the load conditions into consideration. This being true, why should the majority of readings on condenser No. 8 plot as the writer has illustrated by the dotted line in Fig. 1?

From the foregoing it is evident that a plant-economy curve is not really true when based on the results of readings obtained on all the machines, as each machine has its own characteristics.

It is far better to plot a separate curve for each machine and to hold the load constant as far as possible on the machine in question. The best reference curve can be obtained on each machine by plotting the absolute pressure in inches and the kilowatt load separately. If possible, the readings should be taken three times a day and three days a week. It would also help to a considerable extent to obtain the three readings, at low, normal and peak loads. When taking the readings, place *S* or *W* under the curve of each machine to represent whether the condenser is steamed or washed. This can be obtained by observation of the log obtained on the third watch. A set of these curves covering the period of a year will be of some benefit to the chief, especially when the intake-water temperature is stated on each curve, as in Fig. 2.

It also helps considerably to run a water-rate test on a machine occasionally in order to check up its performance as a whole. Moyer states that within the limits of a few inches of vacuum the cost of the turbine is not changed enough to make it a factor in determining the most profitable operating vacuum.

Fig. 3 illustrates the percentage gain in economy per inch of vacuum for various vacuums. A close agreement between the actual and theoretical curves is worthy of notice. The writer recommends F. R. Wheeler as an authority on condensers, and his article on "Condensers and Heater Calculations," which appeared in *Power*, Vol. 40, No. 17, is worthy of careful reading.

Determining Vacuum Best Suited to Conditions

Having the quantity of condensing water required, the cost of fuel and the cost of water delivered to the condenser, the vacuum best suited to the conditions under consideration may be readily determined. Fig. 4 might be of interest to the reader as it gives a set of curves of vacuum at sea level for varying temperatures of cooling water. Fifteen degrees difference between the temperature of the condensed steam and that of the discharge water is usually applicable to modern surface-condenser installations.

No. 1 curve of Fig. 4 gives the theoretical possible vacuum plotted against the temperature of the cooling water. In this case the ratio of the water to the steam is infinite. The results of No. 2 curve take place in a perfect condenser when the ratio of the water to the steam is 60 to 1 and no temperature difference of inlet and outlet cooling water. No. 3 shows an actual condenser at water and steam ratio 60 to 1 with 15 deg. water difference. No. 4 shows an actual condenser working at 15 deg. water difference and 100 to 1 steam water ratio.

Having the temperature of the circulating water in degrees F. and the approximate ratio of the water to the steam, the approximate economical vacuum may be obtained. This is only applicable provided the difference of the inlet- and outlet-water temperatures does not exceed fifteen degrees.

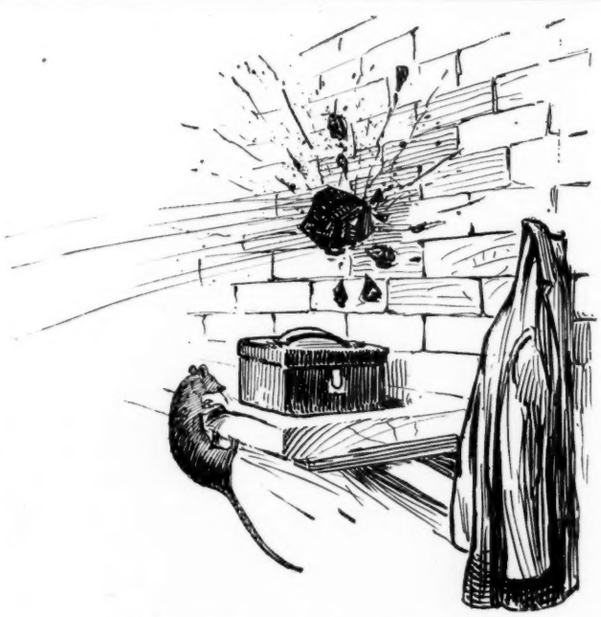
However, it is the opinion of the writer that the kilowatt load should be taken into consideration along with the other factors such as cooling-water temperature, steam consumption, etc., in order to determine the most economical vacuum. It is necessary when carrying the high economical vacuum at high load, to bear in mind that a slight change in vacuum will cause considerable variation in the load. In other words, the meaning of "Watch your vacuum" must be explained to the turbine operator from this point of view.

As the steam expands through the turbine, from boiler pressure to exhaust, its volume increases rapidly. Unless the steam passages become correspondingly larger, congestion of the steam results, with consequent loss of efficiency. It is due to this fact that a vacuum of 28 in. accomplishes little or no improvement over a vacuum of 26 in. when taking into consideration the reciprocating engine. Its low-pressure cylinder could not be designed large enough to expand steam economically, higher than 26 in. Hence, unless the low-pressure buckets and exhaust openings are frequently overhauled and looked after in regard to ample size, little advantage is gained by high vacuum. Stress must be also laid on the peripheral admission of steam on the first and last stages of the turbine.

A variation in vacuum can also take place due to the wear on the turbine buckets caused by the erosive action of wet steam and from the corrosion from impurities in the steam. High superheat will in some cases cause deformation resulting most of the time in interference at the running clearances.

All the facts cited tend to show that in order to locate vacuum trouble, consideration must be given to the turbine unit as a whole, not simply to the condenser and condenser auxiliaries.

In addition to the set of yearly curves as outlined in Fig. 2, a vacuum maintenance record as given by Mr. Smith in his Fig. 2 would be of great service.



COAL WASTE VS. FOOD CONSERVATION

EDITORIALS

Do Technical Courses Need Revision?

MANY of our universities and technical schools suffered serious depletion in ranks through voluntary enlistment and the draft. Coming on top of this, the Student Officers' Training Corps tended toward further disorganization of the courses.

There has not yet been time for the schools to recover from these effects, and many are seizing the opportunity to give serious thought to a readjustment of courses to meet changed conditions, so that a fresh start may be made next fall. In several of the larger institutions these contemplated changes are taking the form of less specialization in the technical courses.

While such plans are under advisement, serious thought might well be given to making the mathematical training more effective. The practice in most of our technical schools is to provide a thorough training in pure mathematics during the first year, but after the student has successfully passed his examinations the subject is put behind him and he breathes a sigh of relief. This is contrary to Continental practice, which, upon graduation, holds the student responsible for the work covered during the whole course.

It is not intended to pass judgment here upon the relative merits of the two systems. Doubtless, each has its advantages as well as its disadvantages. It may be significant, however, that in certain branches of the army requiring applied mathematics many of our reserve officers were lamentably rusty.

Pure mathematics are fundamental as well as useful for training the mind, but they should be supplemented by more applied mathematics given at such time as will make the most lasting impression.

Would not a course in applied mathematics in the last half of the senior year meet the requirements of the case? At this time the student's training has reached such a stage that he is better able to appreciate the relation between the practical and the theoretical, and only such applications need be given as he will be likely to encounter later in the engineering profession.

Water Power in Canada and in the United States

ACCIDENT of geographical location places most of the important industrial and commercial centers of the Dominion of Canada within easy reach of hydro-electric generating stations that are capable of furnishing an abundant supply of power. Because of the remarkably low cost of development, this power is produced economically and the result is a widespread use of electrical energy throughout the Dominion.

As brought out elsewhere in this issue, Canada utilizes two hundred and seventy-six hydraulic horsepower for each thousand of her population. Comparison with the United States cannot readily be made, because the latest figures available for this country are those of 1912. At that time this country used about twenty-five hydraulic horsepower per thousand population. Making an unusually generous allowance for increase of water-power development during the last few years, it seems certain that even now the United States does not make use of one hundred horsepower of hydro-electric energy per thousand population. Compared with our northern neighbor, our per capita utilization of hydro power is only from one-fourth to one-third as great.

The reasons for this apparent backwardness on our part are two: Lack of adequate legislation governing the methods of exploitation and higher costs for development and transmission. Congressional action on the Administration Water-Power Bill has been delayed for months, despite the need for increased supplies of power, and the indications are that nothing conclusive will be accomplished during the present session.

Those localities which would benefit most from a prompt and properly safeguarded development of water power have not forgotten the matter, however. The Northwest, which contains some of the most desirable water-power sites in the country, is loud in its protests against the dilatory methods being pursued at Washington. Senators and Representatives are being bombarded with letters from their constituencies declaiming against the policy of inactivity. Congressional inertia is proverbial, but it must eventually yield to the urge of national necessity.

Government-Owned Machine Tools for Industrial Training Schools

BETWEEN two and three hundred million dollars' worth of machine tools were purchased by the Government for war work, and now that they have served their purpose, the problem of disposing of them to the best advantage is being considered. According to the terms of the appropriation bill under which they were bought, they must be sold so as to bring the greatest possible return to the Government, but there are serious objections to such a procedure.

Perhaps a third of the tools can be installed in existing arsenals. To throw the remainder on the market to be sold at sacrifice prices would practically demoralize the machine-tool industry; for most of the machine shops of the country are already supplied—even overstocked—with tools. Thus, building of new tools would come to a standstill and workmen in that field of labor would be added to the lengthening line of the unemployed.

A plan has been suggested whereby such adverse conditions may be avoided, and a bill has been introduced in the House to enact the project into a law. Briefly, the bill proposes that the Secretary of War shall be empowered to lend these machine tools to trade and technical schools, colleges, universities and other educational institutions that in his judgment should have

such equipment. Adequate provision is made to protect the interests of the Government by making each institution thus equipped responsible for the proper care and safe return of the tools when they are demanded, ordinary wear and tear excepted.

The passage of this bill is desirable, for it will provide means for the industrial training of the children of those who have bought and paid for the machinery. At the same time the Government will be relieved of the expense of storage charges and the material will always be subject to immediate recall if it should be needed in the event of future war.

Beware of comparative figures unless they are reduced to the same basis. A boiler with a certain evaporation per pound of coal may be considerably less efficient than a boiler with a lower evaporation, a higher steam pressure and colder feed water.

The appearance of power-plant equipment is a good index of whether the man in charge takes interest in his job and knows his business, for thorough grooming is the first requisite of careful inspection to obtain knowledge of the conditions.

Supplying the fireman with coal and telling him to keep up steam is not engineering. There is something more for the fireman to do besides keeping up the steam pressure; there is such a thing as efficiency.

Saving or wasting twenty-five per cent. of the coal consumption of any steam plant depends upon the efficiency of the operating department. If there is a waste the plant will be benefited by a change in the operating management.

Increased Costs Make Raise in Price Necessary

Attention is called to an announcement elsewhere in this issue concerning the contemplated increase in subscription price.

The price of "Power" has been held at two dollars for the past eleven years. During this period the cost of paper, engraving and labor involved has practically doubled—in some instances more than doubled; that of paper alone now being over twice the subscription price.

Yet regardless of the ever increasing cost, greater and greater effort has been expended toward making the paper more attractive, making the illustrations tell their story better and in securing material that will be of greatest benefit to the reader in preparing him to hold a bigger place in the engineering world.

The unjustifiable zone system of postal rates has also placed a heavy burden on publishers, amounting in the case of "Power" to approximately the subscription price. But this part of the story has been told before.

What has been the answer? It is to be found in the fact that the majority of magazines, both popular and technical, as well as daily newspapers, have been forced to raise their prices. Some have doubled them.

But "Power" is not passing the whole burden on to the reader. In raising the price to three dollars, it is asking him only to bear a small share. It is even going further than that in permitting present subscribers to renew at the old rate.

We feel confident the reader will appreciate these facts and continue the hearty coöperation and pleasant relations that have marked the past.

Universal raising of wages cannot permanently improve the condition of the workers if it is accompanied by smaller output and shorter hours. There must be greater efficiency and increased production.

The purpose of the grate is to support the fuel bed, but one would not take this to be a fact judging from the appearance of some of the ashpits one sees.

Well, anyway, one gets a lot of consolation in the thought that that stuff he tried to burn last winter helped win the war.

Most chief engineers draw the line when it comes to sociability with their firemen. If the chiefs showed a little more interest in their firemen and in their work, the prospects are that the results would be agreeably astonishing.

All sorts of automatic appliances are used in the power plant, but human intelligence and supervision are required to keep them in proper working order. The man with the automatic brain has not yet been evolved.

Much has been published regarding the care of boilers, engines, turbines and other power-plant apparatus. How about the economizer? Is it not neglected more studiously than any other apparatus in the plant?

Do not make the mistake of assuming that all types of stokers will burn all sizes and grades of coal with equal facility. This is as much of an error as to assume that a crow can fly as fast as a carrier pigeon.

It is just about a year ago that the crews in many plants gathered up all the cord wood, packing cases and the chief's desk to keep up steam when the company trucks returned from the coal yard—empty.

Poor power-plant equipment and supplies are handmaids of the devil that encourage profanity and keep men from going to church.

Now that the Fuel Administration no longer can be held responsible, coal consumers await the edicts of the dealers with bated breath.

Just what science has done and is doing has been brought to the attention of the average man during the four years of war. The advance made in some branches has been wonderful and astonishing.

Thorough Americanization is the governor that will prevent revolution from wrecking the national machine.

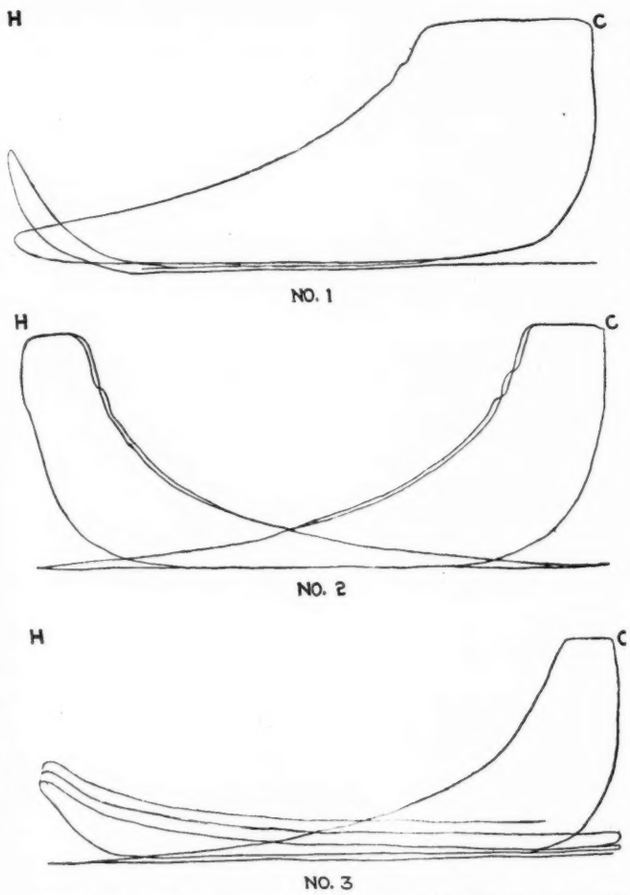
The index to Volume 48 (the last six months of 1918) is ready and will be sent to all whose names are on the index mailing list. Any others who wish will be put on the list. A post card request is sufficient.

CORRESPONDENCE

Odd Indicator Diagrams

Now that the war is over perhaps we can get back to discussing some of the engineering troubles we encountered while keeping the old machines going to produce supplies for "over there."

The engine from which the diagrams shown were taken is a 24 x 42-in. four-valve with gridiron steam valves and Corliss exhaust valves and operates non-condensing. The engineer noticed that suddenly the exhaust became very uneven and found that the head-end steam valve did not open—the latch did not reach over far enough to engage the block. The engine seemed to be running fairly steady, although taking steam at one end only, so he took indicator diagram No. 1 while wondering what had happened. The head end shows only a compression diagram, all the work being done on the crank end; but what had happened to cause this? All bolts on the reach rods seemed tight and nothing had slipped, apparently. At last he measured the length of the two dashpot stems and found the head-end stem was ¼ in. shorter than the one on the crank end. Giving the locknut a "hard try" with his hand, he found it loose, and the stem and dashpot had revolved around and screwed in (shortened) until the latch could not reach the latch block and pick it up. Turning the dashpot around, he unscrewed the stem, thus raising the block until the hook engaged and the valve was again operating. After tightening up the locknut while the engine was still running, he took diagram No. 2. This incident shows what may happen to an engine, and that the difficulty may sometimes be discovered and readjusted in fifteen minutes' time without a stop.



ONLY SLIGHT MISADJUSTMENT DISTORTED DIAGRAMS

On another occasion diagram No. 3 was taken from the same engine. The engine was running full speed and racing slightly. The dashpot on the head end was bouncing and the latch did not engage the block in the ordinary way, and as the hook came over while the valve was open, it forced it shut, but it would spring back from the cushion in the dashpot chamber. The peculiar diagram was probably caused by the reaching of the governor to equalize the load between the two ends of the cylinder, as diagram No. 3 indicates a variation in the steam lines and also leakage of steam into the cylinder after the valve was supposed to be closed. It was found that the packing in the stuffing-box was a trifle tight, and the stem being worn jammed the packing so that the dashpot vacuum could not overcome the friction and excessive compression caused by a choked-up dashpot relief valve. The dashpot relief valve was cleaned out while running and the packing in the stuffing-box loosened until the valve dropped shut freely, and the usual good diagram was produced.

R. A. CULTRA.

Cambridge, Mass.

Motor Suddenly Reversed

In regard to John R. Steeska's inquiry in the issue of Jan. 21, page 102, the reason why the motor stopped, reversed and ran in the opposite direction was that the polarity of the armature or field poles was changed, in all probability because a loose rocker-arm allowed the brushes to shift. Just previous to the reversing, the machine should have sparked badly. A case like this happened once in a plant where I was employed.

This also could occur during an electrical storm, as the lightning might injure the motor in such a way as to cause it to reverse. The writer has also known this to occur at the Colorado Smeltery in Butte, Mont.

Butte, Mont. COLIN F. MCGIBBON.

[It is rather difficult to imagine anything that a lightning discharge could do to a motor to cause it to reverse. It is more likely that something happened to cause the machine to reverse simultaneously with the lightning discharge and in cleaning up the effects of the lightning the cause of the motor's reversing was remedied without being found.—Editor.]

Economy in Using Few Pumps

Many buildings are equipped with an unnecessary multiplicity of pumps. In several buildings which I have in mind there are high-pressure drip return pumps and also heating return pumps. In winter they are enabled to shut down the high-pressure drip pumps by connecting the bottom of the high-pressure drip tanks with the heating-system return, and an equalizing pipe is carried from the top of the tank to the heating system above the water line. The water and vapor thus goes to the heating system. The water is handled by the heating return pump and the vapor is utilized in heating the building, the atmospheric vapor pipe being closed off in winter. W. T. MEINZER.

Brooklyn, N. Y.

Generators Would Not Operate in Parallel

Recently, I was called into a plant to investigate the reason why a second-hand compound-wound generator that had been installed a short time previously would not operate in parallel with the other machine in the plant. An investigation indicated the condition shown in Fig. 1.

It will be seen that the equalizer connection on machine No. 2 is connected between the armature and the positive bus. Furthermore, closing the equalizer switch short-circuits the armature of machine No. 1 and connects machine No. 2 across the series field of machine No. 1. Fortunately, the machines were belt-driven or the damage done might have been much more serious than badly burned commutators and brushes, before the circuit-breakers opened and cleared the trouble. On making the equalizer connection between the armature and series field on machine No. 2 and determining that the polarity of the two machines was correct, they were paralleled without any further trouble.

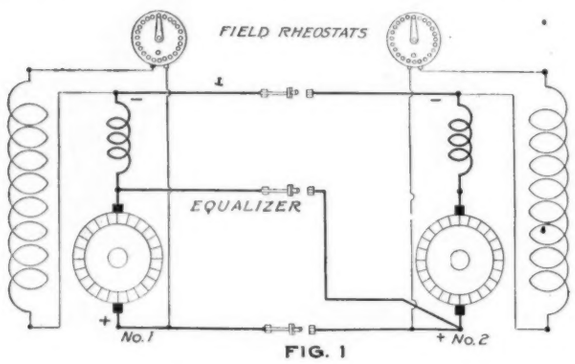


FIG. 1

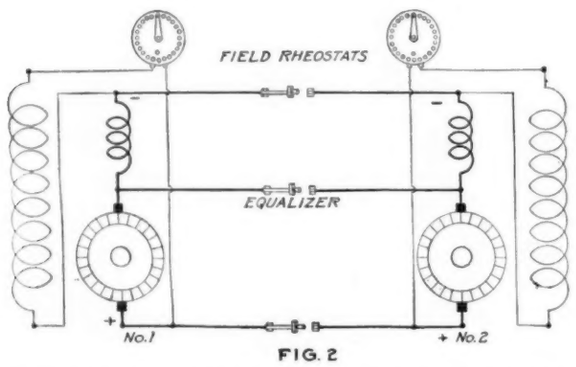


FIG. 2

FIGS. 1 AND 2. SHOWS WRONG AND CORRECT CONNECTION OF EQUALIZER

It is evident from the figures that a wrong equalizer connection between two compound-wound generators may cause just as serious a condition as attempting to parallel two machines having opposite polarity—a condition that too much care cannot be exercised to avoid.

Brooklyn, N. Y. E. C. PARHAM.

Backing Out Broken Setscrews

Occasionally little difficult jobs will be encountered, and sometimes they are hurry jobs when time is the controlling element or the lack of suitable tools makes simple tasks difficult. In most cases a little ingenuity will solve the problem. We read of kinks at different times, but the suggestion cannot always be used at once, although the idea may be recalled at the proper time when there is a real need and put into use. Following are two kinks I have used with success:

TOOL FOR BACKING OUT BROKEN SETSCREW

The first case where speed was essential was a problem of backing out a broken setscrew. This was accomplished by drilling a hole in the setscrew and then turning a tool as illustrated into the hole and backing out the screw. This tool has a left-hand thread or spiral and can be made from a piece of square stock, with a slight taper. The thread is formed by heating the metal, holding one end in a vise and twisting the other end clockwise, forming a rough left-hand thread. It can be finished off if necessary with a file.

In the other case poor contact at the brush on the field rheostat of a 400-kw. alternator heated, and the brush was bound so tightly in the holder that it had to be drilled out. This destroyed the brush and a new one was required. The brush was $\frac{3}{8}$ in. in diameter and had to fit snugly in the holder. The size of copper nearest to this was 1 in. in diameter. No lathe was available to turn it to the proper diameter and filing was out of the question. The difficulty was overcome by using a set of dies to cut the stock to the proper diameter, by using progressively smaller dies so that the stock was quickly and accurately cut to a proper fit in the brush-holder. JAMES M. PURCELL.

Richmond, Va.

Making Diesel Operators from Steam Engineers

Harte Cooke, in *Power* for Jan. 7, says: "Have you ever heard it asserted that a Ford automobile needed an extraordinarily skilled attendant due to these (high) pressures and temperatures?" No, I don't believe anybody has said that a machine costing less than $500 required such an attendant. However, I would like to ask Mr. Cooke if he would be so imprudent as to employ any

of those thousands of jitney drivers such as are found in the Eastern cities, to operate the fine and expensive engines built by his company. I am sure no good executive would be so downright careless and inefficient.

Then Mr. Cooke says: "The ideal engineer to have in charge of a Diesel engine installation is one that is a good executive to see that his force actually does the work which should be done." This is true. But you do not find this kind of men hanging on trees, like apples. The kind of men essential in the power plant are the type that is careful, painstaking and can be trusted, and I have found such men to be scarce.

Comparing a Ford with a power plant is no comparison at all. The vital difference is this: A Ford may stop for the want of gas or a hundred and one other things. The driver can give the jitney joy riders their money back and tell them to catch the next car on the trolley line; or if it carries a load of merchandise, he can shove it over in the corner along the fence, go to the nearest telephone and call another Ford to come to the rescue of a brother in distress. But think of a factory or central power plant tolerating such methods! Have you ever heard anybody say it would be an easy matter to shove a balky Diesel in the corner and call up the machine shop to send around another Diesel right away? What would customers say, if when the lights went out and they called on the phone to find out the trouble, the engineer or the general manager would reply: "Our Diesel got hot and blew her head off; but we will have another Diesel some time next week if the railroads don't get snowbound!"

Coming down to brass tacks, let me say this: The men that will make good with Diesel engines are of the same type that has made good in steam plants; namely, the men that are cautious, careful and take a stitch in time. This is the whole difference between a good power-plant operator and the ordinary man and explains why such a man is worth more money than an unskilled laborer. The old adage says, "It isn't the amount you make; it's the amount you save." And so it is with the engineer: It isn't the amount of work you do; there's a lot in taking care of things. WALDO WEAVER.

Franklin, Ohio.

High-Lift Centrifugal Pumps for Irrigation

Although I was interested in the article on "High-Lift Centrifugal Pumps for Irrigation," by B. P. Fleming, on page 138 of the Jan. 28 issue of *Power*, I am not satisfied as to the author's explanation of the decreasing friction head with increased discharge, in the case of parallel operation of the four pumps. It would, perhaps, be enlightening if we knew where the discharge- and suction-pressure readings were taken for the case of parallel operation.

Referring to his Table I. it is evident that these pumps have a falling head-capacity characteristic; that is, the capacity falls off with an increase of head. Turning to Table II, it will be seen that the aggregate capacity of the four pumps operating singly is 112.28 sec.-ft., while the capacity of the four pumps operating in parallel is given as 108.01 sec.-ft., a difference of nearly 2000 gal. per min. The logical conclusion is that the pumps are operating against a higher head in parallel operation than when operating singly. In other words, the total head for parallel operation must have been more than 88.5 feet.

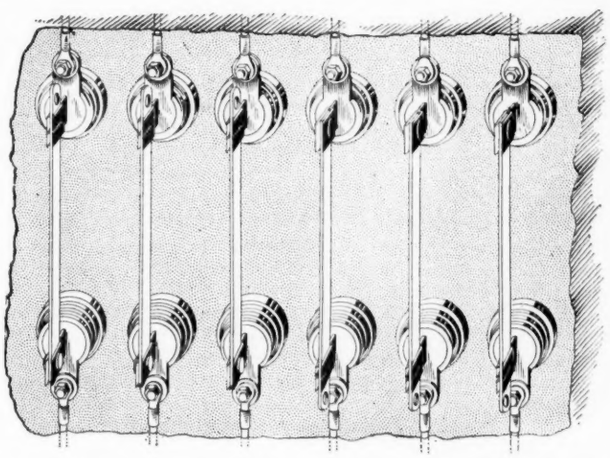
It is hardly reasonable to assume that the improved flow conditions more than offset the increased friction head, when the discharge is quadrupled. As a matter of fact, there is a greater probability of there being heavy swirls and eddies in the manifold with four pumps going than with one only, due to the four converging streams.

I am inclined to think that a velocity or friction head has been overlooked in the case of parallel operation, and this would account for the lower pump efficiency in this case. W. F. BRYE.

Patterson, Calif.

Installing Disconnecting Switches

When installing the disconnecting switches in one of our substations, it was found necessary to mount them on the ceiling, for the incoming lines. As the switches for the different circuits were installed so that they



ARRANGEMENT OF DISCONNECTING SWITCHES AFTER CHANGE WAS MADE

all pointed in the same direction, it was somewhat difficult to identify the individual switches of each circuit. It occurred two or three times that the operator was about to open a switch on a live circuit when he thought it was on one that was out of service. To overcome the possibility of making such a mistake, the switches on every other circuit were reversed, as indicated in the figure. D. R. HIBBS.

Philadelphia, Penn.

Thermos-Bottle Principle Applied to Steam Cylinders

I have operated several compound engines with cylinders or receivers steam-jacketed, and in many instances I found that the jacket steam was shut off as it was considered wasteful to leave it on. In fact, this seems to be common practice, as the radiation losses are considered greater than the benefits derived.

It occurs to me that the principle of the thermos bottle could easily be applied to these cylinders or receivers by plugging the inlets and connecting the drips to the condenser, as these engines nearly always operate condensing. This would be no hardship on the

condenser, as very little air could penetrate the jacketing walls. Then if neither air nor cold can penetrate through a vacuum, all the heat delivered by the high-pressure cylinder to the receiver would have to go to the low-pressure cylinders.

I am not in a position at present to try this, but would like to hear from readers of *Power* who may have tried it or opinions regarding its merits.

Somerville, Mass. JOHN COLE.

Discussion on Motor Starting Resistance

In the Dec. 24 issue of *Power*, page 927, Gordon Fox asked for information on the following points regarding my article on "Method for Determining Resistance Used for Starting Various Types of Motors," in the Nov. 19 issue:

1. A justification for the tables and illustrations of the action in the case of two or three motors—typical cases.

2. The reasons for specifying so many more resistance points with manual control than with magnetic control.

3. The tables given apply to shunt motors, 50 per cent. compound motors and series motors. How should this information be applied to standard compound motors with 20 per cent. compounding and 40 per cent. compounding?

4. Some discussion of the comparative resistance for use with series motors with series lock-out control as contrasted with speed-control service would be valuable.

5. The current values at which resistance sections should be cut out with shunt motors are given. Are similar data referring to series motors available?

6. Mention has been made only of the proper ohmic value of accelerator resistors. Information as to desirable current capacities would be valuable.

7. Information as to the proper resistance for series motors subjected to plugging service.

8. Information as to resistors for dynamic braking and for dynamic lowering, as in crane service and armature shunts for slow-down work.

The following are answers to the several questions asked by Mr. Fox as enumerated in the foregoing:

1. If two or more motors of the same size are in multiple and controlled by one resistor, the same constants and multiplier should be used as if only one of the motors were being considered and the only factor that need be changed is the normal resistance. To illustrate, if there are three 25-hp. 230-volt shunt motors to be operated in multiple and the full-load current of each is 93 amperes, the total current will be $3 \times 93 = 279$ amperes. Therefore, the normal resistance $= \frac{230}{279} = 0.824$, which corresponds to 2.473 ohms in Example I of the original article. Thus, $A_1 = 0.078 \times 0.824 = 0.0643$; $B_1 = 0.0643 \times 1.78 = 0.114$; $C_1 = 0.114 \times 1.78 = 0.203$ ohm. If there are two 230-volt motors connected in series on a 230-volt line, then the resistor would be the same as for one motor. If there are two 250-volt motors in series on 500 volts, then the resistor would be for a motor twice the horsepower rating of one and for 500 volts calculated the same as above.

2. There are usually more points on a manual control than on a magnetic for two reasons: The first is because it does not cost as much to add points to a manual control; and second, because it is essential to keep the voltage from point to point at a minimum so as to reduce the resultant arcing.

3. Tables II, III and IV in the original article give constants for shunt, 50 per cent. compound, and full series motors respectively, but not values for other than 50 per cent. compound. To obtain values for any desired compounding, calculate with the aid of Tables II and IV the resistor divisions for a shunt motor and also the same number of divisions for a series motor. A compound-motor resistor will have values between these two. By obtaining the difference per division between the shunt- and series-motor resistors and then taking a percentage of these differences corresponding to the percentage of the series turns, such as 20 or 40 per cent., and adding it to the shunt-motor resistor values, the desired results will be obtained.

4. The values of ohms determined by the tables are the maximum values which should be short-circuited out of circuit per step, and Mr. Fox refers to this method as series lock-out acceleration. These same values can be used for speed-control service. If equal increments of speed per division are desired, then divide the divisions into equal ohmic values, but these ohmic values should not be greater than the corresponding values determined by the tables, but they may be as "small" as desired. Usually a compromise between the table values and equal increment values are used.

5. Table VII gives constants for use with direct-current shunt motors and wound-rotor induction motors starting centrifugal fans. This information was not given for series motors because series motors are not usually applied to this type of load.

6. The capacities of the resistors used for various services depend upon the kind of resistor unit and upon the severity and frequency of starting. A resistor having an average amount of thermal capacity and a comparatively light and infrequent starting duty should have a continuous current capacity of from 30 to 40 per cent. of the current rating of the motor. If the service is very frequent, the resistor should have a continuous current capacity of from 40 to 60 per cent. of the motor rating.

7. Resistors to be used for plugging series motors are dealt with in Example XI, which shows that values obtained from the tables are for accelerating a motor. To provide for plugging, another resistor division should be added which contains approximately twice the ohmic value used for accelerating.

8. The question of dynamic-brake resistors for use on crane service cannot be dealt with very well without the exact connection diagram. If Mr. Fox wishes any detailed data on some particular arrangement, I will be glad to correspond with him regarding it.

Schenectady, N. Y. B. W. JONES.

The statement that wastes in the boiler room equal all other plant losses combined may appear to be rather sweeping, but is it? When fuel losses, hot-water losses, steam losses and combustion losses are considered, the statement could be made more sweeping in reference to some steam plants.

INQUIRIES OF GENERAL INTEREST

Compressed Air No Assistance to Suction Lift—Would not compressed air, introduced at the top of a capped well casing, be of assistance in raising water with a pump suction pipe that is let down in the casing? J. H.

The compressed air will simply depress the level of the water in the casing without any effect of raising the level of the water in the pump suction pipe, for it would continue to depend on the head and flow of the ground water. If the air pressure were sufficient to depress the water down to the foot of the casing, it would prevent any water from entering the casing.

Knock in Low-Pressure Cylinder with Light Load—What would cause a knock to set up in the low-pressure cylinder of a compound condensing engine whenever the load is reduced and the vacuum goes from 26 in. to about 28 in.? R. H.

If the knock with the lighter load is heard like a slapping noise, as though the exhaust valves are driven from their seats, it may be attributed to expanding the steam below the pressure of the exhaust. The trouble would be remedied by increasing the relative length of cutoff of the low-pressure cylinder. But if the knock is in the nature of a pound, such as might be due to slack connecting-rod brasses, it probably would be due to insufficient compression of the exhaust for good cushioning effect. To obtain the same amount of compression and cushioning on the exhaust with the lighter load and higher vacuum, the lower pressure of the exhaust will require the exhaust valves to be set so they will be closed earlier in the stroke.

Meaning of "Pound of Steam"—What is meant by a pound of steam? Is it not a pound of water evaporated into a pound of steam? W. D.

The expression "a pound of steam" means mass of the substance whose weight is one pound avoirdupois, just as signified by the terms a "pound of feathers" or a "pound of lead." When a pound of water is evaporated, it is converted into a pound of steam, and when the steam is condensed it is converted back to the same weight of water; consequently, the weight of steam is commonly expressed in pounds weight of water required for generation of the steam, or pounds of water resulting from its condensation. When speaking with reference to the condition of the steam, the expression "pounds of steam," as most commonly used, refers to the pressure exerted per square inch above the atmosphere, or "gage pressure," but when quantity is referred to, the expression "pounds of steam" refers to the weight of steam under consideration.

Selection of Initial Pressure—In operating a 150-hp. noncondensing Corliss engine my superintendent claims more steam is used at 80 lb. boiler pressure than there would be for 100 lb. pressure. I believe there is less steam used at 80 lb. pressure. Which is right? A. E. S.

Analysis of indicator diagrams taken of the average load probably would reveal which is right. If the load is such that for steam at 100 lb. pressure the required point of cutoff results in expansion to not less than about 3 lb. above the pressure of the exhaust, then it would be more economical to supply the engine with steam at 100 lb. pressure. Otherwise the lower initial pressure would be more economical, for although there would not be as much work of expansion realized from the later cutoff, there would be a higher terminal pressure and the less range of cylinder temperature would result in less loss of heat from the cooling effect of the exhaust than in case of higher initial pressure and a lower terminal pressure.

Use of Air Chambers with Pumps—Why are some pumps made with air chambers while others are not? C. R. K.

The purpose of an air chamber is to provide an elastic element for taking up the shocks and irregularities and for inducing a uniformity of flow in the pipe line. In single and in duplex single-acting pumps, although the reversal may be instantaneous, there is of necessity a momentary stoppage that is attended by an interruption of the flow and, for smooth running, an air chamber is necessary to take up some of the water during the stroke and replenish it during the pause. An air chamber should be used with crank and flywheel pumps of any type on account of the rapid fluctuations of piston speed, but they may be dispensed with in duplex double-acting low service pumps, in small duplex pumps for general service and in small slow-running pumps such as deep-well bucket pumps and for use with centrifugal and ordinary types of rotary pumps where the flow is nearly continuous.

A. C. Voltage on Rotary Converter—If the direct-current voltage of a six-phase rotary converter is 250 volts, what must the alternating-current voltage be at the collector rings? C. A. R.

The value of the voltage at the collector rings of a six-phase rotary converter to give 250 volts at the commutator will depend upon how the converter is connected to the transformers. If in double delta, the voltage at the collector rings will be the direct-current voltage times 0.612, or in this case $250 \times 0.612 = 153$ volts. If a diametrical connection is used, then the alternating-current volts equal the direct-current volts times 0.707 or $250 \times 0.707 = 176$. A third arrangement is the six-phase connection in which the alternating-current volts is equal to the direct-current volts times 0.354; in this problem $250 \times 0.354 = 88$ volts. These voltages are theoretical values; in practice the voltages will probably be about 5 to 10 volts higher. The connection generally used is the diametrical arrangement as this allows employing the highest alternating-current voltage at the collector rings.

Kilovolt-Amperes and Power Factor—I am in charge of a 600-kv.-a. alternating-current generator and would like to know the meaning of kilovolt-ampere and how horsepower is figured from it; also the meaning of power factor. M. J.

The power (watts) delivered by a direct-current generator is equal to the volts times amperes. In an alternating-current generator this is true only when the current is in step with the voltage, consequently the product of the volts and amperes, with respect to power, may mean anything from zero to the value of their product; therefore kilovolt-amperes (kv.-a.) has been adopted as a unit for rating alternating-current generators, synchronous motors, synchronous condensers and transformers. For a single-phase circuit the kv.-a. $= \frac{EI}{1000}$; in a balanced two-phase circuit, kv.-a. $= \frac{2EI}{1000}$; and on a balanced three-phase circuit kv.-a. $= \frac{1.732EI}{1000}$, where E equals the voltmeter reading and I equals the ammeter reading. The wattmeter will give the load in kilowatts and this divided by kilovolt-amperes gives the power factor; that is, power factor $= \frac{\text{kilowatts}}{\text{kilovolt-amperes}}$; from which kilovolt-amperes $= \frac{\text{kilowatts}}{\text{power factor}}$ and kilowatts = kilovolt-amperes × power factor. Horsepower $\frac{\text{kilowatts} \times 1000}{746}$ or $\frac{\text{kilovolt-amperes} \times \text{power factor} \times 1000}{746}$

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications.—Editor.]

Industrial Unrest*

The industrial problem which confronts not only our own country but all civilized nations, is probably the most vital one with which we as citizens have to deal. Extreme radicalism, either on the part of Government, labor or capital, will not heal the wounds caused by the many suspicions, misunderstandings and even animosities that are the outcome of the long struggle which the world has been making to keep the pendulum of human rights at the equity mark, halfway between overbearing capitalistic autocracy on the one hand and the anarchistic elements on the other.

Neither is it proper to throw all the blame for the present unfortunate industrial conditions on capital or all on labor or all on government. There are many who have decided ideas on this subject, but it must be constantly remembered that the interested parties in this triangular dispute are labor, capital and the government.

Throughout all allied countries workers of all kinds recently rose in defense of the ideals of liberty, democracy and world peace, and they counted no price too great for their protection; yet, at the same time, there is grave danger that the benefits of our great victory for these ideals may be wholly nullified by the widespread dissensions and misunderstandings in the industrial world.

To capital should be pointed out that the laborer is worthy of his hire, that right working conditions and surroundings should be safeguarded to him, that more and more the profits and benefits of successful business must be equitably divided among those who produce the profits which it has come to be realized now means both the employed and the employer.

It must be pointed out to capital that labor can be no longer successfully exploited, that fair dealing is due to the workman by his employer, just as fair dealing is expected by the employer from his workmen.

To labor it must be pointed out by those in authority at the head of our Federal and State Governments that the interests of capital and labor are in the end identical—that the man who rows the boat, if he scuttles it with the idea of giving the man who steers it an unpleasant cold bath, will get the same bath himself.

To labor it must be pointed out that Anarchy and I. W. W.ism and Bolshevism, all more or less synonymous, are as contrary to the high ideals of American citizenship as anything could well be. To labor must be pointed out that we have just won a victory of right against might and that the temporary ability of a trade-union organization to secure unjustifiable and uneconomic hours of work or dollars of wages is but the Prussian idea of might over right; that there must be reasonableness in all things, even the demand of labor, and that labor must be constantly awake to the dangers which confront it, not from outside in the form of the employer so much as from within in the shape of the alien agitator, the unamericanized anarchist or the pro-German Bolshevist who in fanatical fury would pull the industrial structure down upon their own heads.

No department of the United States Government, whether it bear the name of "Labor Department" or "Capital Department," should ever approach the problems pertaining to that department from one side only. A labor department that merely represents labor does not make for industrial harmony and peace; neither does class legislation which has for its goal benefits which accrue to the employer or capital only, make for industrial peace. On the contrary, they are more likely to bring about an industrial catastrophe that may well wreck the hopes and aspirations of all citizens of the United States, whether they be employers or employees.

There is the great question of restriction of immigration before the Congress of the United States today. It may well be that that measure supported strongly by labor is part of a plan to create a corner in the supply of labor. If so, to enact it would be to perpetrate a great economic wrong on a country whose very greatness is the result of immigration of years to its shores.

Legislators must be taught, and I use that word advisedly, that one-sided legislation is one of the worst things that can come out of a Congress.

If the employer profiteers, it is well that the politician and statesman should cry out again t it from the housetops. If labor profiteers, it is equally proper that statesmen must utter their open condemnation of such a proceeding.

I. W. W.ism, Bolshevism, hurling of monkey wrenches into the machinery of social order, both at home and abroad, must stop, and someone with a voice loud enough to be heard must utter the warning.

In closing I want to say as an American citizen, proud of my country, that while America may, and undoubtedly does, need readjustment to the new state of things, it does not need revolutionary reconstruction, and it is the patriotic duty of every publisher and editor to see that, above all else, reconstruction is not attempted by alien agitators, Unamericanized socialists, and many other pro-German elements, now more or less carelessly classified as Bolshevists.

*Excerpt from an address by Roger Allen before the New York Business Papers Association.

Horsepower Developed from Water in Canada

A census of the developed water power in the Dominion just completed by the Dominion Water-Power Branch of the Department of the Interior, in coöperation with the Dominion Census Bureau, discloses exceptionally interesting figures. The water-power resources of Canada, with their strategic locations adjacent to practically every industrial center, constitute one of the greatest assets, and it is satisfactory to note that the economic advantages accruing from utilization of these powers for industrial purposes is being fully realized in practice.

The accompanying table analyzes the installed turbine or waterwheel capacity of the Dominion by provinces, and by use of power. The returns indicate a total developed water-power capacity of 2,305,310 hp. The figure is several hundred thousand in excess of any estimate previously published and indicates that Canada's utilization of hydro power is even more marked than had been realized.

Of the total water power developed, 1,727,471 hp. is installed in central electric stations, that is to say, in stations developing electrical energy for distribution and sale; 352,214 hp. is installed in plants owned and operated by pulp and paper companies, and 225,625 hp. is installed in other miscellaneous manufacturing and general industrial establishments. The foregoing figure for pulp and paper companies does not, however, represent the total amount of water power used in that industry; upward of 100,000 hydro-electric horsepower in addition, is purchased by pulp and paper companies from central electric stations, making the total hydro power utilized in pulp and paper industry some 450,000 hp. If this 100,000 hp. is added to Column 2, it should be subtracted from Column 1 to maintain the correct tabular totals.

Returning to the central electric station total of 1,727,471 hp., it is of interest to record that the central stations already constructed throughout the Dominion are designed for a machine installation of 530,000 hp. in addition to the machinery now installed. Of this amount the installation of 270,000 hp. is at the present time under contemplation in various parts of the Dominion. These figures do not include the 300,000-hp. Queenstown plant which the Hydraulic Power Commission of Ontario has under construction at Niagara.

Column 5 of the table discloses interesting figures respecting the hydro-power development in the various provinces on a per capita basis. In the Yukon the hydro power developed per thousand population totals 1574 hp., in British Columbia 506 hp., in Quebec 376 hp., in Ontario 359 hp., and in Manitoba 133 hp. The other provinces average smaller figures. The ratio for the entire Dominion averages 276 hp. developed per thousand population. The availability of hydro power, the distribution, density and occupation of the population have a very direct bearing on the amount of power developed.

The exceptionally high ratio in the Yukon is accounted for by extensive use of hydro power in the mining industry in conjunction with the comparatively small population.

The per capita figures of hydro power developed for the Dominion, when compared with similar figures for other countries, are indicative of the advanced position which this country takes both in the extent and in the utilization of its water-power resources. Norway and possibly Sweden are the only countries where the per capita utilization of water power exceeds that of Canada. The most recent figures available for the United States would indicate a utilization of less than 100 hydraulic horsepower per thousand population, as compared with 276 per thousand in Canada. The fundamental reason underlying the extensive use of water power in Canada is the fact that practically every commercial center from coast to coast, excepting only a few in the middle Prairie Provinces, have abundance of water power available, not only for present needs, but for all anticipated requirements.

DISTRIBUTION OF DEVELOPED WATER POWER IN CANADA BY PROVINCES AND BY USE OF POWER, JAN. 1, 1919

Province	Central Electric Stations Horsepower	Pulp and Paper, Horsepower	Other Industries, Horsepower	Total Horsepower	Horsepower per 1000 Population
Yukon....	10,000	.....	3,392	13,392	1,574
B. C.....	221,625	46,450	44,348	312,423	506
Alta.....	32,580	.....	300	32,880	63
Sask.....	.....	.....	.....	.....	.....
Man.....	64,100	.....	12,072	76,172	133
Ont.....	791,163	133,952	59,945	985,060	359
Que.....	597,601	155,512	89,648	842,761	376
N. B.....	6,878	2,800	5,191	14,869	41
N. S.....	3,354	13,500	9,170	26,024	51
P. E. Id...	170	.....	1,559	1,729	19
Total...	1,727,471	352,214	225,625	2,305,310	276

Iron and Steel Electrical Engineers Discuss High-Voltage Fuses

The Pittsburgh Section of the Iron and Steel Electrical Engineers held its regular monthly meeting in the roof garden of the Hotel Chatham, Pittsburgh, Penn., Saturday evening, Feb. 15, 1919. The meeting was preceded by an informal dinner at 6:30, which approximately 100 members and guests attended.

The meeting was called to order at 8 p.m. President D. M. Pettie, after a few brief remarks regarding the work of the society, introduced Alfred Alsaker, who presented a paper on "Outdoor Substation Practice and the Use of Carbon Tetrachloride Fuses." In his introductory talk Mr. Alsaker pointed out how the problem of supplying large communities with electrical power from large economical power plants was solved by the introduction of high-voltage alternating current, this power being transmitted to economically located substations in various parts of the community and distributed in various forms from these indoor substations. This also made possible the development of our large water-power resources. However, the equipment used for large cities was not suitable for small communities, on account of the high cost of substations, and it remained for the development of the outdoor substation to solve the problem of serving small towns from large high-voltage systems. In these stations air-break type switches in general are used and protection is obtained by the use of various types of high-voltage fuses. The speaker described three types of the fuses—the horn-gap type, the inclosed type and the carbon-tetrachloride type. The last-named type is also an inclosed fuse of special construction using a short piece of fuse attached to a spiral spring under tension in a tube filled with carbon tetrachloride. When the fuse blows, the spring recoils into the opposite end of the tube, introducing a long break in the circuit, and the carbon tetrachloride rushes in and quenches the arc. It was brought out that the carbon-tetchrachloride fuse could open a circuit in 0.013 part of a second.

After the presentation of his paper Mr. Alsaker showed a large number of lantern slides of various types of outdoor substations, and then followed a discussion, in which a large number took part. During this discussion it was brought out that carbon-tetrachloride fuses had ruptured a circuit at a maximum instantaneous load, as shown by an oscillograph, of 132,000 kv.-a. at 110,000 volts, and that automatic air-break switches had ruptured 90,000 kv.-a. when located on the end of a 40-mile, 44,000-volt transmission line. The meeting was closed by Vice President B. W. Gillson.

The next meeting will be held by the Philadelphia Section at the Engineers' Club, Saturday evening, Mar. 1, 1919. A paper, "The Substitution of Electric for Hydraulic Power in Steel Mills," will be presented by R. B. Gerhart. A meeting of the Cleveland Section will also be held on Mar. 1 at the Electric League Rooms, Hotel Statler, Cleveland, Ohio. "Telephones" is the subject to be discussed at this meeting.

Standardization of Boiler Blowoff Valves

At a meeting at the Engineering Societies Building, New York City, Thursday, Feb. 13, a number of representative blowoff-valve manufacturers gathered for the purpose of considering matters of importance regarding the manufacture of boiler blowoff valves, especially the standardization of flanges and the elimination of unnecessary sizes and varieties of valves.

It was the sense of the meeting that there was no engineering demand for freak designs, which are frequently asked for by some consulting engineers and others, such as flanges at one end and screwed connections at the other, steel body castings, special markings, etc., all of which make it necessary for the manufacturer to carry a large number of patterns. Although special valves cost more to manufacture, the purchaser expects to obtain them at the same price that he pays for a standard article. Again, a certain size of blowoff valve may be made standard with screwed end connections, but flanged valves must be carried to meet the demands for such when they are made.

After considerable discussion the following recommendations were made, to be submitted for a referendum to all manufacturers of blowoff valves who were not represented at the meeting. If the recommendations as made do not meet the views of the manufacturers as a whole, they will be modified or enlarged until all can agree on a common basis.

The first recommendation adopted was that not smaller than 1-in. and not larger than 2½-in. boiler bottom boiler-blowoff valves be manufactured, these sizes being those recommended by the A. S. M. E. Boiler Code, the intermediate sizes to be 1½- and 2-in. only.

Regarding connections, the recommendation adopted for blowoff valves for use on power boilers operating with pressures up to 250 lb. was that such valves be made extra-heavy pattern only, and that the 1-in. sizes have screwed connection, the 1½- and 2-in. sizes screwed or flanged, and the 2½-in. size flanged only. It was, however, recommended that the 1½- and 2-in. sizes be preferred flanged.

A final recommendation was that the manufacturers should reduce the variety of styles to the smallest number of types possible, in the interest of conservation and economy.

It is proposed that as soon as all the blowoff-valve manufacturers agree as to the types and sizes that good engineering requires, their recommendations be submitted to the Industry Committee on Valves and Pipe Fittings, which has succeeded the War Service Committee, for approval and adoption. This will be necessary if harmony in fittings is to prevail.

In the boiler and engine rooms care should be exercised to see that the passageways are kept clear, and that fire tools, barrows and other obstructions are kept in their proper places. Fuel and ashes should also be kept within restricted limits.

Where a safety valve blows off across the top of a boiler the outlet should be so extended that the steam will be discharged vertically, above body level if practicable.

Water-Power Development in France

On Monday evening, Feb. 10, 1919, in the auditorium of the Engineering Societies' Building, New York City, at a joint meeting of the American Institute of Electrical Engineers, American Society of Mechanical Engineers, American Society of Civil Engineers and the American Institute of Mining Engineers, the delegation of American engineers to the French Engineering Congress, recently held in Paris, made a preliminary report on the work of the congress. Lewis B. Stillwell was chairman of the committee appointed by the delegation to represent it at the Paris Congress, on water-power development. In making his report Mr. Stillwell said in part regarding water-power development in France:

There are three important water-power districts in France: The region of the Alps in southeastern France, drained by the Rhone and its tributaries; the northern slopes of the Pyrenees; and the elevated region in the south-central part of France, drained for the most part by streams flowing northward into the Loire and westward into the Garonne. Of these the region of the Alps is by far the most important. It is estimated that the total hydraulic power available for commercial development in France is approximately 4,500,000 hp. Hydro-electric plants thus far installed aggregate a capacity of approximately 1,000,000 hp., of which about 800,000 hp. are in the watershed of the Rhone and its tributaries.

In the valley of the Romanche the Société Electro-thermique Keller-Leux is installing a power plant which will utilize in one step a fall of 1100 m. (3608 ft.) The diameter of the pipe is 18 in. (45.7 cm.). Another development which particularly interested the committee is the manufacture of iron pipe by electrolytic deposit of iron upon revolving cylinders.

At the beginning of the war there were in Dauphine 29 hydro-electric stations, producing an aggregate of 170,000 hp. At the end of June, 1918, 40 plants were in operation, producing approximately 220,000 hp. It will be noted that, notwithstanding the extreme urgency of war conditions, the increase is only 50,000 hp., although far larger amounts of undeveloped power are available in this region and if developed would have been of the utmost value to France.

The time available to the delegation did not permit a visit to the region of the Pyrenees. The impetus toward water-power development has been felt in this region, and several important plants are now in operation, including one of approximately 20,000 hp. and another of 32,000 hp. The committee was informed also that two projects are under way in that region which will employ for transmission purposes a potential of 120,000 volts. The highest hitherto used in France is 60,000 volts.

The third water-power district is that of the Massif of the south-central part of France. This region is extensive in area and there are a number of streams of high aggregate fall, but these streams are not large and the potential power possibilities of the region are by no means comparable to those of the Rhone.

In the years immediately preceding the great war the annual consumption of coal in France was something over 60,000,000 tons. Of this amount approximately one-third was imported. The average price then was from $5 to $6 per ton. It is probable that in the future the price will be materially higher, probably about $8 per ton. It is obvious, therefore, that France should develop her water power as rapidly as may be practicable.

The Engineering Congress at its session in March last adopted recommendations looking to the standardization of frequency and voltage. It was recommended that 50 cycles per second be adopted as the standard frequency and that the use of 25 cycles per second be permitted in special cases.

Operator Saves Turbine

At the station of the New Bedford Gas and Edison Light Co., an operator, by his coolness, probably prevented material damage to a 15,000-kw. turbine by tripping the throttle and staying with the machine until it had stopped, after a piece of the last, or ninth, wheel had let go and blown through the low-pressure casing. The machine, which at the date of the accident, Feb. 6, had been in service about a year and a half, was of the single-cylinder horizontal type, the last wheel being about 100 in. diameter and running at a relatively low peripheral speed—460 ft. per sec. The machine had been synchronized, and when the load reached about 200 kw. the accident occurred.

An investigation is now being made into the causes of the failure, and the finding will be awaited with interest by engineers in general.

Cutting boilers in and out, forcing them to operate at too high or allowing them to run at too low rate of steaming, attempting to change the rate of combustion too rapidly and failure to equalize the combustion rate as much as possible on all the boiler units being fired, all add to the waste of fuel.

Youth is the expanding, affirmative period, early manhood the experience period, middle age the period of balance, slower to acquire but safer to advise; subsequently occurs the conservative period, making gains secure, when a novelty must be startling to arouse interest, later still nothing excites any reflex action.

Steam-pipe loss is brought about partly by convection, but mainly by radiation. It is also greater when steam is flowing through the pipe, as when the engine is running, than when there is no flow. Moisture in steam and its deposition on the pipe surface assist in the transfer of heat to the pipe.

New Publications

RESULTS OF MUNICIPAL ELECTRIC LIGHTING IN MASSACHUSETTS. By Edmond Earle Lincoln, Instructor in Economics, Harvard University. Published by Houghton Mifflin Co., Boston and New York. Cloth; 484 pages; 5½ x 8 in.; 16 charts; numerous statistical tables. Price, $3.

The author of this book has made an exhaustive study of the municipal electric-lighting situation in the State of Massachusetts with a view to determining how it compares with private enterprise in the same field. To that end he has collected and analyzed a vast amount of data concerning legal regulations and restrictions, the physical equipment of stations, the financial statistics of generating and purchasing plants and their local background. He compares public business with private business at its worst in the state and reaches the following interesting conclusions: That municipal electric-lighting plants, while they have not been failures, have not shown conspicous success; that they perform services which might have been rendered equally well, if not better, by private enterprise; that under existing regulations in Massachusetts there is no reason why a municipality should invest in an electric light plant, certainly not a generating plant; that the public can hope for better service from plants under group control, properly regulated, than from those independently owned and operated; and finally, that municipal plants should be required, by law if necessary, to be conducted exactly as if they were commercial enterprises, so that the public may understand whether they are gaining or losing. There probably will be some who will disagree with the author's findings, but none will question his intention to analyze the problem thoroughly and impartially.

MAN TO MAN; the Story of Industrial Democracy. By John Leitch. Published by D. C. Forbes Co., 299 Broadway, New York City. Cloth; 250 pp.; 5 x 7½ in. Price $2.

The author believes that the present condition of industrial unrest, due to the changing status of industry and the increased cost of living, demands imperative remedial action. He explains that industrial democracy has been evolved through years of experiment based on the fundamental principle of justice between employer and employee. Its machinery, which is modeled after the legislative machinery of our Federal Government, provides the means of communication by which the opposed ends of the industrial organization may get together, learn each other's trials and limitations and cease to be opposed. Citations of the workings of systems as installed in industrial establishments occupy four chapters of the book. The author shows that in these cases the system has had the effect of increasing production and profit, while at the same time it has increased the financial returns of the employee, eliminated the spirit of unrest and substituted a feeling of mutual confidence.

STORING. By H. B. Twyford. Published by D. Van Nostrand Co., New York City. 1918. Cloth; 6 x 9 in.; 215 pages; 96 illustrations. Price, $3.50.

This book treats of storing, its economic aspects and proper methods in manufacturing plants. The author looks upon the question of "To store or not to store" as one of great economic importance to manufacturers and one that must be settled, in many cases, on a more scientific basis. The book is divided into 12 chapters, namely: General Considerations; Economic Questions Connected with Storing (two chapters); Specifications, Definitions and Standardization; Location and Equipment of Storeroom; Appliances for Use in Storeroom; Manual Operation; Clerical Work—Inventories; The Stores Department; Receiving Material; Inspecting and Placing Material in Storeroom; and Deliveries from Storeroom. The subject is considered from

the practical side as well as from the theoretical. The construction of various types of bins and racks and their location in storerooms are not only described, but a number of illustrations are given which make the chapter on this subject of exceptional value. The chapters on appliances and manual operation, give numerous appliances and equipments, including trucks, scales, counting machines, conveyors, tote boxes, etc., for handling both raw and manufactured materials. Numerous forms are given in Chapters VIII to XII for making out inventories and keeping record of materials received, stored or delivered, etc. This work should prove of valuable assistance to all those who have manufacturing, storage and handling problems to solve.

PRACTICAL HINTS ON RUNNING A GAS ENGINE

The United States Department of Agriculture has issued Farmers' Bulletin 1013, with the foregoing title, its purpose being to assist in conserving farm labor by offering practical help to operators of gas engines. It mentions the more common causes of trouble with gas engines and suggests methods of locating quickly the reason for the failure of the engine to operate as it should. Directions are given for testing the ignition system and the fuel system and there is an extended discussion of the problem of starting in cold weather. At the end of the bulletin is a chart for diagnosing engine troubles systematically. The sixteen pages contained in this publication are full of information clearly written and easy to understand and apply.

CENTRAL STATION HEATING

This bulletin is Technical Paper 191 of the Bureau of Mines and deals with the economic features of central-station heating with reference to community service. It points out that at best only about 15 per cent. of the heat of the fuel can be converted into electrical energy and that 6 per cent. is common, so that great gain is possible by combining steam power plants and central-station systems. It discusses the question of rates and costs of such heating and makes the following recommendations: It would appear advantageous to select plant locations more favorable to the district to be served; adopt more permanent construction materials and improved designs; submerge the power load entirely at all times during the heating season; put all consumers on meter rates with an equitable demand charge; run compound engines, or exhaust the turbines tandem to simple engines during the summer months.

Obituary

Frederick L. Hickock, president of the Reliance Gauge Column Co., of Cleveland, Ohio, died of pneumonia at his residence in East Cleveland on Feb. 16, after a week's illness. He was 36 years of age. He was connected with the Ingersoll Milling Machine Co., Rockford, Ill., for five years, and was associate editor of "Machinery" for four years. He was a member of the University and Advertising clubs and of the Windermere Masonic Lodge. He is survived by his widow and three daughters.

Personals

Theodore ... Hermanson, formerly of the Harrison (N. J.) works of the Worthington Machinery Corp., is now works manager of the Epping-Carpenter Pump Co., of Pittsburgh, Penn.

Wyan Eaton, who until recently was engineer in charge of the rolling mill work of the Mesta Machine Co. has been appointed chief engineer of Freyn, Brassert & Co., Engineers Peoples Gas Building, Chicago.

Lewis S. Maxfield, formerly mechanical engineer for the Carver & Nate Co., engineering contractors, has resigned to become assistant to the secretary of the Heating and Piping Contractors National Association, 29 West 39th St., New York City.

Alfred H. Bartsch, formerly advertising manager of the Bosch Magneto Co., and for the last two years merchandising and advertising counsel to many large automotive industrial firms in Philadelphia, has been appointed general sales and advertising manager of the American Bosch Magneto Corp.

Charles H. Herter, for many years research engineer with the De La Vergne Machine Co., New York, and well known in ice and refrigerating circles, has entered the employ of Chas. A. Schieren Co., 30 Ferry St., New York City. Mr. Herter will specialize on belting calculations in Schieren's engineering service department.

James N. Hatch, consulting engineer, Chicago, has formed an association with Henry C. Eckland, architect, and formerly connected with Eckland, Fugard & Knapp. The new firm will be known as Henry C. Eckland & Co., architects and engineers. Mr. Hatch, however, will continue his consulting practice of public utility and industrial engineering as heretofore.

Col. C. H. Crawford, of Philadelphia, has been elected director of the American Association of Engineers to succeed T. M. Chapman, deceased. Colonel Crawford served in the purchase, storage and traffic division of the general staff of the War Department during the war, and has recently taken employment with the Baldwin Locomotive Works at Philadelphia. He has been interested for a number of years in the unity of the engineering profession, and was an active member on the committee on coöperation, representing the Engineering Association of Nashville.

Engineering Affairs

The Association of Iron and Steel Electrical Engineers, Philadelphia Section, will hold a joint meeting with the American Institute of Electrical Engineers on Mar. 1. Dr. W. S. Franklin, of the Massachusetts Institute of Technology, will lecture.

The Eccentric Association of Firemen, No. 56, I. B. of S. F., held its twenty-fourth annual entertainment and ball on Feb. 11, at the Star Casino, New York City. There was a good vaudeville show and dancing was a feature of entertainment.

Miscellaneous News

The Engineering Experiment Station, University of Illinois, at Urbana, maintains fourteen research graduate assistantships. Two other such assistantships have been established under the patronage of the Illinois Gas Association. These assistantships, for each of which there is an annual stipend of $500 and freedom from all fees except the matriculation and diploma fees, are open to graduates of approved American and foreign universities and technical schools. Nominations to these positions must be received by the director of the Station each year, not later than Mar. 1. Additional information may be obtained by addressing the director of the Station.

The Fourth Lyon Fair will be held in Lyon, France, Mar. 1 to 15. The fair is under the patronage of the President of France and of the Minister of Commerce and Industry. The Organizing Committee of the fair is under the presidency of Senator Edouard Herriot, mayor of Lyon. The United States Department of State and Department of Commerce have endorsed the fair. On account of the apparent interest manifested by American manufacturers and exporters the Fair officials have now arranged to place additional space at the disposal of American exhibitors. The Committee of the Fair has sent a special representative to the United States to aid American firms and individuals that may care to exhibit their samples.

The Professional and Special Section of the United States Employment Service, formerly located at 299 South La Salle St., has removed to new and more extensive quarters at 63 East Adams St., Chicago. This section, formerly known as the Division of Engineering, will enlarge its service to include all kinds of professional and technical men and women. During the war this branch of employment did notable work in placing engineers and technical men in various branches of the war and the Government. Now its activities will be directed toward reconstruction and peace needs. Engineers and professional men and women desiring the services of the Professional Section, are requested to write to the above address for registration blanks. In order to secure quick service, applicants are advised to communicate with the branch of the Professional Service which has jurisdiction over their zone district. People living in Illinois, Indiana, Iowa and surrounding territory should register with the Chicago office. No charge is made for this service.

Business Items

The Wisconsin River Power Co. has moved its general offices from 73 West Adams St., Chicago, to 16 Carroll St., Madison, Wis.

Badenhausen Co. announces the opening of its Pittsburgh office at 5030 Jenkins Arcade, with A. D. Neeld, Jr., in charge. This office will cover sales in Ohio, West Virginia and western Pennsylvania.

The Barber-Greene Co., of Aurora, Ill., announces the following additions to its staff: W. A. Buell, formerly conveyor engineer of the Goodyear Tire and Rubber Co., sales engineer; H. W. Cudding, formerly general auditor of the Lyon Metallic Manufacturing Co., auditor.

The H. W. Johns-Manville Co. has this year distributed to all its salaried employees an extra compensation of 20 per cent. on the salaries paid them during 1918. It has been the custom of this company for some years past to recognize the faithful service of its employees in this manner.

The De Ved Kissick Co., Inc., New York City, announces that it has added to its line of power-plant fuel and labor-saving specialties the vapor and vacuum heating systems of the Illinois Engineering Co. for the New York territory. This new department will be under the supervision of A. T. Browne, who has been active in the heating and ventilating field for the past eight years.

Edward R. Ladew Co., of Glen Cove, New York, announces some changes in its Southern organization, as follows: O. S. Horton has been appointed manager of the Southern branch, with headquarters at Charlotte, N. C., and territory covering all states south of Maryland, West Virginia, Kentucky and Arkansas, west to Texas; Walter Carr, formerly of the New York office, is assistant branch manager.

Trade Catalogs

Sidney Open-Back Inclinable Presses. Sidney Power Press Co., Sidney, Ohio. Catalog. Pp. 8; 8½ x 11 in. This illustrates and describes the types of flywheel press manufactured by this company.

Ball and Roller Bearings. Gwilliam Co., 253 West 58th St., New York. Catalog. Pp. 18; 6 x 9 in. This illustrated booklet gives the dimensions and specifications of all types of ball and roller bearings.

The Service Engineering Co., 25 Church St., New York, has issued a four-page circular telling who the company is, what it does and how it does it. Interested parties may obtain this circular by writing for it.

N. G. E. A. 1918 Blue Book. Issued by the National Gas Engine Association, Lakemont, N. Y. This is a classified directory of the members of the Association. It contains a copy of the constitution and by-laws.

Zelnicker's Bulletin No. 259. Walter A. Zelnicker Supply Co., St. Louis, Mo. Catalog. Pp. 16; 3¾ x 8½ in. Giving specifications of all kinds of tanks. Interested parties may obtain a copy by writing to the Walter A. Zelnicker Supply Co., St. Louis, Mo.

The De Laval Steam Turbine Co., of Trenton, N. J., has issued a 32-page illustrated catalog (Bulletin M) entitled "Geared Marine Steam Turbines," describing standardized geared turbine units for marine service, details of construction of turbines and gears and also various turbine-driven auxiliaries, including lighting sets, circulating pumps, boiler feeders, etc.

The Heine Safety Boiler Co., St. Louis, Mo., has just completed the printing of the latest edition of its "Boiler Logic," an 86-page treatise on steam boilers, which covers the following topics: Some fundamental consideration of boiler design; practical baffling of water tube boilers; Heine boilers for different fuels; overloads; the boiler as a pressure vessel, and details of construction, Heine boilers.

The Crescent Principle of Belt Joining. Crescent Belt Fastener Co., 381 Fourth Ave., New York. A four-page circular which summarizes the reasons why people buy Crescent belt fasteners. Instructions for making a Crescent joint are given, and it contains a ready-reference service chart by means of which the correct type of belt fastener can be determined. Copies may be obtained by writing to the company.

New Construction

Proposed Work

Conn., Bridgeport—S. Z. Poli, 24 Church St., New Haven, will install a vacuum system in the 3 story theater which he plans to build on Main St. Total estimated cost, $400,000. T. W. Lamb, 644 8th Ave., New York City, N. Y., Arch.

Conn., New Haven—The New England Iron Works, Inc., 96 Commerce St., plans to build a 1 story, 60 x 150 ft. plant, to include a power plant, on Albert and Welton St. Total estimated cost, $40,000.

Conn., Waterbury—S. Z. Poli, 24 Church St., New Haven, will install a steam heating system in the 1 story theater which he plans to build here. Total estimated cost, $500,000. T. W. Lamb, 644 8th Ave., New York City, N. Y., Arch.

N. Y., Iona Island—The Bureau of Yards & Docks, Navy Department, Washington, D. C., plans to build an extension to the power plant here. Estimated cost, $30,000.

N. Y., Massena—The Aluminum Co. of America plans extensive improvements and additions to its plant here. Plans include the absorption of several small power users on the Grass and St. Regis River to centralize power development.

N. Y., New York—The City Realty Co., 176 Broadway, will install a steam heating system in the 2 story, 189 x 213 ft. theater which it plans to build at 4810-4127 Broadway. Total estimated cost, $100,000. H. J. Krapp, 114 East 16th St., Arch.

N. Y., Troy—The Mohican Co., 280 Broadway, New York City, will install a steam heating system in the 3 or 4 story, 56 x 150 ft., retail market building which it plans to construct at 361 River St. Total estimated cost between $100,000 and $150,000.

N. J., Newark—The American Oil & Supply Co., 52 Lafayette St., will install a steam heating and sprinkler system in the oil plant which it plans to build on Wilson Ave. Total estimated cost, $1,000,000. P. B. Taylor, Essex Bldg., Engr.

N. J., Verona—The Board of Freeholders of Essex County, Court House, Newark, plans to build a power plant here. Runyon & Carey, 843 Broad St., Newark, Engr.

Penn., Blairsville—S. S. Richard, Altoona, plans to build a hospital and group of institutional buildings near here, consisting of power house, administration building, laundry, etc. F. McCrooks, Jones Law Bldg., Pittsburgh, Arch.

Penn., Erie—The Griswold Manufacturing Co., 12th and Raspberry St., is in the market for a 14 in. x 6 ft. Hendy geared motor driven tool room lathe with taper attachment, a 2 in. motor driven radial drill and a 24 to 30 in. motor driven planer.

Penn., Johnstown—The Board of Directors of the School District will receive bids until Mar. 15 for the construction of the main school building and the boiler house of the group of 6 buildings, known as the William A. Cochran School, in the 8th Ward. C. H. Meyer, Secy.

Penn., McKees Rocks—The Pittsburgh Railway Co., 435 6th Ave., Pittsburgh, plans to build an addition to the power house here, also a new station at Castle Shannon and new tracks at various points. F. Uhlenhart, Ch. Engr.

Md., Baltimore—The City Electrical Commission, City Hall, plans to extend the electrical conduit system into city's new annex during spring and summer. Estimated cost between $150,000 and $200,000. P. G. Ligon, Ch. Engr.

S. C., Charleston—R. L. Riggs, 4 Broad St., will install a steam heating plant and electric elevators in the 3 story, 159 x 170 ft. garage, repair shop and storage building which he plans to build. Total estimated cost, $100,000. J. O. Newcomer, 32 Broad St., Arch.

Ga., Lyerly—The Lyerly Milling Co., is in the market for an electric generator and motor to be installed in the Sarling Mill, which they recently acquired. J. S. Owings, Mgr.

La., New Orleans—The Pelican Ship Ventilator & Metal Co. is in the market for a power drop hammer.

Ohio, Cleveland—J. Grossman, c/o Standard Theater, East 9th and Prospect St., will install steam heating and ventilating systems in the 6 story, 75 x 196 ft. theater which he plans to build on Euclid Ave. near 107th St. Total estimated cost, $300,000.

Ohio, Cleveland—D. R. Hanna, 511 Leader-News Bldg., plans to install a steam heating system in the 16 story, 199 x 210 ft. office building which he plans to build on East 14th St. and Euclid Ave.

Ind., Anderson—The city has been authorized to issue $90,000 bonds with which to make improvements and install new equipment in the electric plant. J. E. Essington, City Clk.

Mich., Detroit—The Waterworks Department has applied for an appropriation for the construction of a new boiler house to accommodate a 600 hp. boiler. C. F. Hubbell, City Engr.

Mich., Wyandotte—E. C. Bryan, City Clk., will receive bids until March 18 for furnishing and installing 2 low lift, motor driven centrifugal pumping units (one 2100 gallons per minute and other 4200 gallons); also for steam driven pumping unit 5,000,000 gallon capacity, horizontal cross compound crank and fly wheel pumping engine. R. W. Pratt, Hippodrome Bldg., Cleveland, Ohio, Engr.

Ill., Chicago—L. E. Waterman & Co., 191 Broadway, New York City, N. Y., plans to install a steam heating system in the 6 story store and office building which they plan to build at 127-129 South State St. Total estimated cost, $175,000. Holabird & Roach, 104 South Michigan Ave., Arch.

Ill., Decatur—The Comet Automobile Co., 156 South Water St., plans to build a power and heating station. The growth of the business of the company necessitates same. Estimated cost, $35,000.

Iowa, Sioux City—The Terminal Grain Corp., Grain Exchange, will install about 600-hp. in electric motors, in the terminal elevator which it plans to build on 14th St., along the Great Northern Railway tracks. Total estimated cost, $140,000. Burrell Engineering & Construction Co., 323 South La Salle St., Chicago, Ill., Engr.

Kan., Ottawa—The City Water & Light Department is in the market for a new 500 kw. generating unit, including condensing equipment for electric plant; also steam engines and turbines. W. O. Myers, Supt.

Kan., Ottawa—The Warner Manufacturing Co. is in the market for a No. 7 Buffalo or a No. 4 Sturtevant cupola blower.

Neb., Omaha—The State Legislature, Lincoln, plans to appropriate $120,000 for improvements to the University of Nebraska College of Medicine, 42nd St. and Dewey Ave., to be used as follows: $40,000 for electrical apparatus, laboratory equipment, etc.; $80,000 for the construction of a 1 story, 30 x 50 ft. heating plant; also pumps, pipe covering, watertube boilers, etc. J. Latenser & Sons, 632 Bee Bldg., Arch.

Okla., Tulsa—The city will soon receive bids for installing a 150 ft. concrete stack and new boilers. R. E. Cuvian, Comr. Water-Works.

Colo., Denver—Armour & Co., U. S. Yards, Chicago, Ill., will soon award the contract for the construction of a 4 story, 58 x 162 ft. boiler house here. H. A. Merick, c/o Colorado Packing & Provision Co., Stock Yards, Denver, Arch.

Colo., Julesboro—The city will soon award the contract for rebuilding the light and power plant. G. H. Austin, Mayor. Noted Nov. 26.

Colo., Silver Plume—The Denbigh Mines Co. is in the market for a double-drum electric hoist, and a second-hand motor driven compressor. H. S. Bushnell, Supt.

Idaho, Nampa—The city plans to build flush tanks, manholes and pump to handle 200,000 gallons per day, in connection with new sewerage system. L. R. Cook, City Hall, Engr.

Ariz., Florence—The town voted in favor of a bond issue for $80,000; $60,000 to be used for water-works improvements and $20,000 for power plant. List of required equipment can be obtained from the Board of Supervisors. Noted Jan. 7.

Wash., Seattle—The Puget Sound Traction, Light & Power Co., Stuart Bldg., has had plans completed for rebuilding its power sub-station recently destroyed by fire. A. L. Kempster, Mgr.

Cal., Modesto—The Waterford Irrigation Dist. plans election soon to vote on a $200,000 bond issue; $170,000 to pay for water rights and $30,000 to extend and improve irrigation works. Pumping plant will probably be installed in Tuolumne River, to lift water 110 ft. for irrigating 13,866 acres. E. N. Bryan, Modesto, Engr.

Cal., Quincy—The Board of Supervisors of Plumas County will install a steam heating plant in the 4 story court house and jail which it plans to build. G. C. Seelon, Mitau Bldg., Sacramento, Arch.

N. S., Sydney—The Dominion Iron & Steel Co. is in the market for material and equipment for its plant.

Ont., Parry Sound—The Town Council plans to build an electric plant and is in the market for machinery for same. Estimated cost, $185,000. J. D. Broughton, Clk.

Ont., Renfrew—The Renfrew Machinery Co., Ltd., is in the market for an electric spot welder, 110 or 550 volt, 60 cycle, 3 phase circuit.

Ont., Toronto—Hyslop Bros., Ltd., 12 Shuter St., is in the market for 1 motor generator set, direct drive, single unit base, 5 hp., 3 phase, 1800 r.p.m., gen. 32 volts, 60 amp., capacity 30, 6 v. batteries at 10 amp., board with 6 leads, volt meter, rheostat and ammeter.

Ont., Toronto—Bids will be received by the Town Clerk, until March 7, for furnishing and installing 1 water-works pumping unit comprising turbine pump of 2000 gallon capacity against 330 ft. head, and steam turbine or gasoline engine, direct connected to pump. Specifications, etc., may be seen at the office of Chipman & Power, Mail Bldg.

Man., Winnipeg—The Dominion Government, Ottawa, Ont., will install a central heating plant and boilers in the Military Hospital which it plans to build at Tuxedo Park. Total estimated cost, $190,000. R. C. Wright, c/o Dept. of Pub. Works.

CONTRACTS AWARDED

N. H., Portsmouth—The Bureau of Yards & Docks, Navy Department, Washington, D. C., received bids for installing piping connections in the power house at the Navy Yard here, from the Carroll Electric Co., 714 12th St., Washington, D. C., $42,800; J. W. Danforth, 70 Ellicott Sq., Buffalo, N. Y., $42,986; Rideout, Chandler & Joyce, 178 High St., Boston, Mass., $44,158.

Mass., Millis—The Cliquot Club Co. has awarded the contract for the construction of an addition to its plant, to the Aberthaw Construction Co., 27 School St., Boston Mass. Project includes a power house, bottling factory, etc. Total estimated cost, $150,000.

N. Y., Brooklyn—J. Kayser, 45 East 17th St., Manhattan, has awarded the contract for the construction of a 1 story, 50 x 55 ft. power house on Classon Ave., to the Caye-Hosford Construction Co., 299 Broadway, Manhattan. A steam heating system will be installed in same. Total estimated cost, $60,000.

N. Y., Iroquois—W. Hunt, Pres. of the Bd. of Managers, Thomas Indian School, received bids for installing refrigeration equipment, from the Moyer Ice Machine & Engineering Co., 315 Grant Ave., Jersey City, N. J., $9400; Mollinberg-Betz Machine Co., 110 Nash St., Buffalo, $9558; Wigner Machine Co., 67 Mississippi St., Buffalo, $9930. Noted Feb. 4.

N. Y., New Hampton—The Commissioner of Correction, Municipal Bldg., New York City, has awarded the contract for the installation and completion of the steam mains and tunnel between the receiving, classification and administration building and the power house at the New York City reformatory here, to L. W. Abrons, 15 East 40th St., New York City. Estimated cost, $4500.

N. Y., New York—Brown Bros. & Co., 59 Wall St., has awarded the contract for the construction of a 4 story, 44 x 88 ft. banking building at 81-83 Beaver St., to Marc Eidlitz & Son, 30 East 42nd St. A steam heating system will be installed in same. Total estimated cost, $150,000.

N. Y., New York—The Daughters of Jacob, 157th St., Findlay and Fuller Ave. (Bronx Boro.), have awarded the contract for the construction of a 5 story, 100 x 150 ft. home, to G. Richard Davis & Co., 30 East 42nd St. A steam heating system will be installed in same. Total estimated cost, $600,000.

N. Y., Utica—The State Hospital Commission, Capitol, Albany, received bids Feb 11, for the following work at the Utica State Hospital; installing new boilers, from Gillis & Geoghegan, 537 West Broadway, New York City, $42,990; McNaull Boiler Works, 983-1015 Front St., Toledo, Ohio, $58,120; E. Keeler Co., 50 Church St., New York City, $67,920; heating work, from the W. B. Armstrong Co., Fulton St. Albany, N. Y., $39,640; Almirall Co., Inc., 1 Dominick St., New York City, $41,975; H. C. Peterson Co., 20 Oneida St., $44,963.